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THE INSTITUTE CONVENTION.

A very interesting and enjoyable convention of the American Institute of Electrical Engineers was held at the Thousand Islands last week. It was notably sociable, for one thing, a kind of house party on a large scale. A better attendance might have been expected and was indeed desirable, for a gathering of less than 300 can hardly be regarded as representative of a society with a membership of over 6000, of which 30 per cent lies probably within a striking distance of 500 miles from the Hotel Frontenac. Indeed, we believe that, had a little time been given to publicity work as to the many attractions of such a delightful resort, the figures of attendance would have been very largely increased. In general enjoyment there has been no such convention since that of happy memory at Great Barrington, Mass., but the diversions were not distractions, and all the sessions were remarkably well attended. Moreover, there were delegates from no fewer than 25 sections and branches—not counting New York—and the dinner, devoted to a discussion of "What Shall We Do with Our Sections?" or words to that effect, was crowded and enthusiastic to a most significant extent. It is evident that the Institute and other kindred bodies are reaching a very important stage of their development in regard to this question of sections—technical, territorial, local, interrelated, popularized and other kinds—and the happy solution of that problem will mean much for engineering in America. Elsewhere in this issue will be found several pages of reports and abstracts.

POWER CHARACTERISTICS OF THE TUNGSTEN FILAMENT.

An interesting article, by Dr. Steinmetz, on the power characteristics of the tungsten filament incandescent lamp appears on page 89 of this issue. The article gives a number of photometric and electric observations on a particular tungsten lamp, between the limits of 2 horizontal candle-power and 320 horizontal candle-power. The power consumed ranged from 12.3 to 123 watts, or increased tenfold; while the current increased in the ratio 2.35, the voltage in the ratio 2.05, and the inferred resistance in the ratio 1.8. Taking the electrical observations, Dr. Steinmetz shows that the power consumed by the lamp increases as the 1.6th power of the terminal voltage, the agreement between the observations and this relation being remarkably close. The deviations are all less than 1 per cent. The article shows, moreover, that if the resistivity of tungsten is in direct proportion to the absolute temperature, and if the power dissipated is all radiated according to the Stefan law of the fourth power of the absolute temperature, then the power must increase as the 1.6th power of the terminal voltage. The deduction is, therefore, that the resistivity of tungsten must be closely in proportion to the absolute temperature. Data on this point are still very scarce, but the resistivity is known to be at least approximately proportional to the absolute temperature, like that of other pure metals. For ex-

ample, very nearly pure copper, whose resistivity behavior is best known to us, acts as though its resistivity were proportional to an absolute temperature commencing at or near —238 deg. C., instead of —273 deg. C., as reckoned by chemists and steam engineers. If copper resistivity were proportional to the chemists' absolute temperature, its temperature coefficient would be 0.366 per cent, like that of gas expansion, instead of 0.42 per cent, as actually observed.

We may, however, in spite of trivial dubitations of the above nature, safely say that the watts as the 1.6th power of the terminal volts is a rational physical law of the tungsten filament reported; whereas, the hysteretic watts as the 1.6th power of the flux density in cyclic magnetization is still only an empirical law, not yet accounted for. In fact, it seems likely that the hysteretic 1.6th power is connected with some law of probability for the rupture of magnetic chains in vast hordes of molecular magnets cyclically rotated about their axes. Indeed, the power is believed to increase slightly at high flux-densities in a gradual manner out of keeping with a precise physical law. We owe, then, two 1.6th laws to Dr. Steinmetz, one, as yet an empirical law of hysteretic energy loss, and the other this new and physically explainable law of power in a tungsten filament, as a function of terminal voltage. The series of tests contained in the article indicates, besides, that the horizontal candle-power of this lamp was approximately proportional to the square of the watts supplied. Thus, taking 32 cp at 39.3 watts, the lamp, at three times the power, or 117.9 watts, should give nine times the candles, or 288. Test No. 25 of the table indicates that 288 candles were, in fact, observed at 117.9 watts. The agreement at this point is exact with a law of squares. It is, however, only maintained within a few per cent throughout the entire series, and is by no means so close as in the electric 1.6th power relation pointed out. Below 10 cp the deviation is considerable. It would be interesting to have this relation tested in other lamps. Photometric observations might naturally be expected to have less precision than electric observations, especially with change of color at low candle-power.

Complete Solution of Transmission Line with Distributed Capacity and Leakage.

As power transmission by electric currents increases year by year, both in kilowatt capacity and in distance of transmission, electrical engineers are beginning to raise their formulas for alternating-current line calculation. In the very early days of alternating-current delivery, when the distances covered were very short, Ohm's law, as known in direct-current service, was applied. In other words, nothing was taken into account in line calculation except ohmic resistance and ohmic drop of pressure. As the line lengths increased from stone's throw to common-shot range, inductance and reactance were found to be worthy of consideration, if any degree of precision was to be attained, and the line calculations were changed to include reactance and impedance drop. About twenty years ago the introduction of high-voltage alternating-current transmission from Deptford to London was found to be accompanied by a slight rise of voltage toward the receiving end of the line at no load. This unexpected phenomenon was named the Ferranti effect. An investigation of this phenomenon led to developing the whole theory of transmission over long lines at any practicable frequency. This theory included distributed resistance, inductance, capacity and leakance. It was worked out and published by various engineers, along different lines, but was far in advance of the transmission needs of that time.

Soon afterward, however, the transmission lines became long enough to require taking their capacity into account. This was done by lumping the capacity either into one middle condenser, or into two equal terminal condensers. The latter is usually the simpler device. It gives a practical and simple set of line formulas sufficiently nearly correct for all present transmission requirements. When, however, the line is made very long, or the frequency is increased to harmonic ranges, the split condenser plan is unreliable, owing to lumpiness error. It is known that a simple formula can correct the split-condenser method for lumpiness, but the usual plan is to fall back upon the formulas for distributed constants. The line engineers are beginning to be practically interested in the complete line theory. It is at present impossible to write down short accurate formulas for long line calculation with distributed constants, unless hyperbolic functions are used. Using algebraic and circular functions, the formulas are all long and unwieldy. It is merely a choice between them as to which is the least long or least unwieldy. An able paper recently presented on this subject to the Frontenac convention of the American Institute of Electrical Engineers developed some practicable formulas that appear to establish a record for length in engineering literature.

The interesting article on page 90, by Dr. Harold Pender, who has a happy faculty for bringing complicated cases of analysis within the range of engineering computation, gives a skilful solution of the same problem, and presents formulas that are accurate in deduction and in practice workable. Until we can avail ourselves of complete tables of hyperbolic functions, it would seem that the formulas in this article are the shortest yet offered, when the full line treatment is required with distributed constants, including leakance. The example worked out in the article relates to a 700-mile three-phase transmission at 25 cycles per second. This is a much greater transmission-distance than any yet covered in practice. Nevertheless, at the frequency of 25 cycles per second there is hardly any difference, from a practical standpoint, between the solutions of this problem by the split-condenser method and by the full line method with distributed constants, such as is given in the article. Consequently, although the full computation which Dr. Pender's formulas render practicable is well to fall back upon, engineers will not go far astray if they continue to rely for preliminary estimates on the shorter condenser methods of line calculation.

Influence of Alternating Current Upon Life of Tantalum Lamps.

It is well known that incandescent lamps provided with filaments of tantalum do not last so long on alternating-current mains as on direct-current mains, all other conditions being alike. Moreover, it has been found that the higher the frequency of the alternating current, at least up to 120 cycles per second, the greater the depreciation in life, in something approaching direct proportion. A low-power microscopic examination of tantalum filaments which have been quickly slaughtered on the altar of

a high-frequency alternating-current service, has shown that their surfaces have lost their pristine glossy smoothness and have taken on a remarkable roughly crystalline appearance, in blocks that call to mind the basaltic pillars of Fingal's Cave. The same disrupted semi-crystalline surface condition may also be observed in tantalum filaments which have died a more prolonged and natural death on direct-current service; but in these, the degree of disruption and disintegration appears to be less marked.

The reasons for the more rapid deterioration of tantalum filaments under alternating-current supply have been recently investigated by Prof. O. Scarpa, in an article discussed by the *Elektrotechnischer Anzeiger*. A number of such filaments were arranged to be operated either by alternating or direct currents, at will, while under examination in a microscope. It appeared that the microscopic image of the filaments was larger with alternating- than with direct-current operation, a condition attributed to rapid transverse vibrations of the filaments. When the filaments are new, their mechanical condition is amorphous. When old, and broken down under alternating-current operation, it is highly crystalline. The disruption of the filament occurs in passing from the amorphous to the crystalline condition. The circumstances that are most favorable to the transformation of any material from the amorphous to the crystalline state are temperature elevation and mechanical vibration. In these tantalum filaments the temperature elevation is nearly the same with alternating- and direct-current operation, although it tends to be a little higher, in each cycle, with the former operation, especially at low frequencies. Since, however, the destructive effects of the alternating current are greater with higher frequencies, it seems safe to conclude that the temperature effect is substantially the same in both alternating- and direct-current operation. But in regard to vibration, the filaments supplied with alternating current have a much more active and exciting experience than those supplied with direct currents.

The vibrations excited in filaments supplied by alternating current may be either of thermal or of magnetic origin. The temperature of a filament subjected to alternating-current operation must fluctuate through a certain range, with double the frequency of the current, and this alone might be expected to produce some vibration of the filament, due to slight periodic changes in length by contraction and expansion. The magnetic vibrations are caused by the motor forces acting on each part of the filament in the magnetic field at its location. The earth's magnetic field alone would be capable of setting up a certain small range of vibration, but the local field is in a larger measure produced by neighboring parts of the same filament. At each reversal of the current the motor force on each portion of the filament either reverses sign, or waxes and wanes, thus tending to set up vibrations, either of the same or double the frequency of the current. We may, therefore, infer that because vibration should occur theoretically in such a filament under alternating-current operation, and is actually observed to occur; and also because such vibration is known to favor crystallic degeneration in a metal—the disintegration of tantalum filaments on alternating-current service is at least in part accounted for. It may still be unsafe to assume that all of the destructive action of alternating currents is due to mechanical vibration. There might be additional, deeper-seated, and more complex molecular actions.

LARGE RAILROAD TERMINAL PLANT.

The new station of the Chicago & Northwestern Railroad, described elsewhere in this issue, is one of the big things of the City of Superlatives. It is not only of very exceptional size, but it is beautiful and well planned. As in most recent terminal stations, the very large electrical supply required for lights and motors is provided by a special plant, in this case of more than usual interest. The output required for the terminal building rises to more than 500 hp in motors, aside from all the lighting demanded by an area of 13 acres in use day and night, and necessarily lighted with exceptional brilliancy. The new power plant is therefore big and planned for the most economical operation. The feature of greatest interest in it is the dynamo and prime mover equipment, in which the exhaust steam turbine plays an important part. The main generators are three 250-volt, 750-kw units driven by compound non-condensing engines. In conjunction with these is a 500-kw exhaust steam set, the turbine being of the Rateau pattern, and guaranteed to deliver the kw-hour on 43.5 lb. of steam at 1 lb. gage pressure with 27-in. vacuum. This is a good performance for such a unit. It will be most interesting later to learn what the practical economy of the scheme may be as thus applied to a new and carefully designed plant. The condenser plant for the turbo-generator is equipped with a cooling tower.

Electrically—the system being intended mainly for work in a very limited area—it is in the main a direct-current proposition with balancer sets to take care of the three-wire distribution. For the yards and freight houses, however, the distances are inconveniently long, and we find the very unusual feature of motor-generators with 250-volt, direct-current motors and 6000-volt, three-phase generators for the long-range work—a complete reversal of every-day precedents brought about by the unusual conditions of distribution. There are two such sets each of 500 kw capacity. In a general way, the plant presents few special mechanical features, automatic conveying and stoking being applied as usual to the regulation thing in water-tube boilers. It is a little surprising not to find the elevators in the main building electrically driven in preference to sending live steam from the power house 1500 ft. to work the pumps. We should have been disposed to think that the balance of economy in such a case would have been on the side of the electric drive. We most earnestly hope that the economic results of this plant will be made public after it has been in service a sufficient period. Data on really large and first-class isolated plants are scarce and not always reliable. Here, however, is a generating station of considerable output working under rather favorable load conditions and designed with economy especially in view. It ought to give excellent results and we want to see them in due time published. The use of exhaust steam is particularly interesting, and we are anxious to learn what the net total water consumption per kw-hour may be under these unusual conditions. The guaranteed steam consumptions for both reciprocating engines and turbines are good, yet it is to be proved how the two will work together, as compared with a regular condensing plant of either kind.

Convention of National Electrical Contractors' Association.

Arrangements for the convention of the National Electrical Contractors' Association, to be held at Toledo, July 21, 22 and 23, have been practically completed. The headquarters of the convention will be in the Boody House, and the open meetings will be held in the auditorium of the Chamber of Commerce. It is expected that the convention will be one of the most successful in the history of the association, invitations having been issued to all contractors, whether electrical or not, to participate as non-members in the open meetings. Among the social features will be a ladies' trolley ride up and down the Maumee Valley, with a luncheon at the beach. July 23 will be devoted to an outing, one of the features of which will be a baseball game between Eastern and Western contractors, captained by Mr. Jas. R. Strong, of New York, for the Eastern team, and Mr. E. McCleary, of Chicago, for the Western team.

At the open sessions on the mornings of July 21 and 22 a number of addresses will be delivered on subjects of interest to electrical contractors. These will include an address by Mr. W. H. Blood, Jr., of Boston, on "The National Electrical Code and the Relation of the Contractor to the Central Station," and another by Mr. Jas. R. Strong, of New York, on "The National Electrical Contractors' Association." Mr. E. L. Elliott, of New York, will address the meeting on the subject of "Illuminating Engineering in the Contracting Field," and Mr. Geo. C. Nimmons, of Chicago, will have as the subject of an address, "The Relation of the Contractor to the Architect." Two other subjects will later be added to this program, which will be considered at open meetings on the mornings of July 21 and 22. The principal topic to be discussed at the closed or business meetings of the association will be license legislation in the various States.

Three Aspects of Railroad Electrification.

At the meeting of the Electric Club, of Chicago, on June 30, Secretary W. S. Taussig presided and the speaker of the occasion was Mr. Edward N. Lake, a division engineer with the Board of Supervising Engineers, of Chicago. Mr. Lake said that he would give a three-phase talk—that is, consider his subject under three aspects. These were the growth, centers and systems of the electric railway, with particular reference to the electrification of steam railroads. The speaker sketched the development of electric street and elevated railways and also the development of electricity as applied to the operation of steam railroads. He mentioned the fact that at the Louisville Exposition of 1883 a small electric locomotive was shown; but nevertheless it is only about two years since the important electrification of the New York Central terminal was accomplished. The commercial world is loth to take up anything new; but when it does take it up, the growth of anything really meritorious is remarkable, as has been the case with the electric railway.

Mr. Lake gave a table showing the growth of the street-railway systems of the United States. In 1890 there were 8123 miles of single-track street railways in the United States, of which 1262 miles were operated by electricity, or 15.5 per cent. In 1907, 17 years later, the total number of miles of street railways was 34,404, of which 34,060 miles were operated by electricity, or 99 per cent. Electric railways have developed suburban areas, and so suburban lines have extended. The tip ends of these suburban lines in nearby areas of population have been connected by interurban electric railways. Thus, the development of the electric railway has been by zones around centers of population: First, urban lines; next the suburban, then the interurban, and now there are a few examples of electrified steam-railroad terminals serving a still wider zone of suburbs and adjacent towns. New York has two electrified railroad terminals and Boston likely will soon have another. It is probable that these zones will in the future be connected by an electric trunk-line railway.

Within the next 10 years it is probable that there will be great activity in the line of the electrification of steam railroads. New York is the great Eastern center of population from which electrified steam roads may be expected to reach out toward other population centers. Chicago may be considered as a similar center for the Middle West. A circle having a radius of 400 miles, with New York as its center, includes all or the larger part of 13 States. A similar circle, with Chicago as its center, includes all or a large part of nine States. Comparing these groups, Mr. Lake showed that in population they were about the same and together included nearly two-thirds of the entire population of the country. In land area in the United States the Chicago group is about twice as large as the New York group and also in railroad mileage the Chicago group has twice the mileage of the New York group. In commercial values of railroad operating property the two groups are about the same. As electrification proceeds these two centers will undoubtedly be electric-railroad centers as they are now steam-railroad centers.

Railroad electrification is a simple matter in its elements and only affects a small percentage of the value of the railway property. It means the substitution for the steam locomotive of three electrical elements: generating, distributing and motive systems. On June 30, 1908, the estimated value of all steam railroad property in the country was $13,000,000,000. Of this the locomotives represented a value of $632,500,000, or 4.86 per cent of the total value. As the average life of a steam locomotive is only about 20 years it is apparent that each of the locomotives displaced by electricity will have abundant opportunity to finish its life on some branch line or remote service, so that no loss by "scrapping" of serviceable equipment need be apprehended. The average nominal horse-power of the steam locomotive is about 500, while the stationary units of a modern electric-power station have a rating of from 10,000 hp to 20,000 hp.

In the New York electrified railroad terminals two different systems have been installed and are in process of trying out. One makes use of the direct current delivered by a third-rail; the other makes use of alternating current delivered by an overhead trolley wire. Similarly in the Middle West in the railroad tunnels under the St. Clair and Detroit rivers, one of which is now building, these two systems will be tried out. The Port Huron tunnel under the St. Clair River is operated by alternating current and the Michigan Central tunnel, now under construction under the Detroit River, will be equipped for direct current. This trying out of the two systems side by side is fortunate for the ultimate development and success of steam-road electrification. Railroad men using these two systems advocate the one with which they are most familiar, but partisans of both sides unite in an emphatic endorsement of the general advantages of using electrically transmitted power for the operation of railroad trains.

Large Fire Loss from Oil Transformer Explosion.

In a recent note brief mention was made of the partial destruction by fire of the station of the Trinidad (Col.) Electric Light & Power Company. From later information it is learned that the total loss was somewhat under $100,000, and that the fire was primarily due to the arcing over of a rotary converter, which short-circuited coils in three oil transformers installed on a wood floor in the same building. Probably owing to low oil, in the case, one of the transformers, which blew the top off, rent holes in the side and scattered burning oil over the wood floor. Within a few minutes the engine-room was untenable, and by the greatest effort only were the fires drawn under boilers and danger of explosion averted before the boiler-house roof fell in. The fire department was helpless when it did arrive, as oil had been by that time blown about from all the transformers in the station. The switchboard was dropped through to the basement. The new high-tension portion of the station was not cut off by a fire wall and was completely destroyed. The only pieces of apparatus in the entire station

not seriously injured were the boilers, two steam turbine units and the storage battery, which latter was only partially cut off and suffered considerable damage from broken plates and jars. No insurance policies were in force, as upon the reorganization of the company a few years ago the risk was re-rated with increases owing to wood floor in bad condition, oil transformers on wood floor and large masses of combustible insulation beneath the wood floor from generators to switchboard. As a consequence the company concluded that it could better afford to carry its own insurance, though the result has hardly borne out this belief.

Joint Wisconsin and Northwestern Convention.

The Wisconsin Electric and Interurban Railway Association and the Northwestern Electrical Association held a joint meeting at the Grand View Hotel, Chain O' Lakes, near Waupaca, June 28 and 29. This summer meeting was called by the officers of the two associations to furnish a means of discussing operating topics of interest to electric railway and light companies and incidentally to give members a chance for a brief outing. Sixteen electric railway and lighting companies of Wisconsin were represented. The sessions were presided over alternately by Mr. Clement C. Smith, of Milwaukee, president of the Wisconsin Electric and Interurban Railway Association, and Mr. Ernest Gonzenbach, of Sheboygan, president of the Northwestern Electrical Association.

One of the important results of the meeting was the consolidation of the two associations, which has been talked about for some 18 months as being desirable and probably inevitable. The sentiment was unanimous in favor of this consolidation, inasmuch as both associations are now practically limited to the State of Wisconsin. Years ago the Northwestern Electrical Association was formed to cover a number of States, but the organization of various State associations within the territory has gradually limited the association to the State of Wisconsin. The Wisconsin Electric and Interurban Railway Association, consisting of electric railway and lighting companies in the State of Wisconsin, was organized recently with the double object of having occasional meetings for the discussion of operating topics and for taking up various matters in connection with the Wisconsin commission and Wisconsin Legislature. The consolidation of the two associations has been hindered somewhat by the fact that the Northwestern Electrical Association has not technically been limited to the State of Wisconsin. Under the new arrangement, individual membership in the association, without vote, but with all other privileges of the association, is given to all former individual members. Individual membership will cost $5 per year. The company or Class A members, with voting power, pay dues at the rate of one-tenth of 1 per cent of their gross receipts.

The question of consolidation of the associations was first brought up in an executive committee meeting of the Northwestern Electrical Association the afternoon of June 28. It then appeared from the statement of the secretary and treasurer, Mr. John S. Allen, that the records and finances of the Northwestern association are in very bad shape. There is no authentic list of Northwestern members, and the association has unpaid bills of over $300, with no money in the treasury. After considerable discussion it was decided to recommend to the two associations a consolidation, to be carried out as follows: The name of the association is to be the Wisconsin Electrical Association. The membership is to consist of companies and individuals as before outlined. Various company members of the Wisconsin association agreed to subscribe enough to wipe out the debt of the Northwestern association, thus allowing the consolidated association to start with a clean slate. Dues are to be paid beginning with Jan. 1, 1910. Owing to the incompleteness of records, no attempt will be made to collect delinquent dues. All present and former members wishing to continue membership will pay alike, beginning with Jan. 1, 1910.

This plan of the executive committee was presented to the association at the morning session June 29 and was unanimously adopted by both associations. The executive committees of the two associations were then directed to draft a constitution and by-laws and nominate officers to serve until the annual meeting in January, 1910. At a special meeting held at 2 p. m., June 29, Mr. C. C. Smith, speaking for the joint committee, reported in favor of a constitution the same as that of the Wisconsin Electric and Interurban Railway Association, with the additional provisions for membership recommended by the executive committee as already outlined. The committee placed in nomination two tickets, one consisting of the former officers of the Wisconsin association and the other of the former officers of the Northwestern association. The election resulted in a mixed ticket from the officers of the two associations, as follows: Mr. Ernest Gonzenbach, of Sheboygan, formerly president of the Northwestern association, was elected president; Mr. Clement C. Smith, of Milwaukee, former president of the Wisconsin association, was elected first vice-president; Mr. Irving P. Lord, of Waupaca, was made second vice-president, and Mr. George B. Wheeler, of Eau Claire, was made third vice-president. The secretary and treasurer is Mr. John S. Allen, of Lake Geneva, formerly secretary of the Northwestern association.

This consolidation will result in one good, strong association for Wisconsin, and will relieve the uncertainty as to the future of the Northwestern Electrical Association which has been hanging over it for some eight years past. Every one was agreed as to the importance of keeping up the work of the Wisconsin Electric and Interurban Railway Association as regards legislative matters.

Lest there be some misunderstanding as to just what this work consists of, a brief account of the association's method of handling legislative matters is apropos. It is well known that whenever a State Legislature convenes numerous bills are proposed which are ill advised and likely to do damage to the industries which they affect. It is necessary that the bad points of these bills be made clear and brought out forcibly to the attention of legislative committees or other members of the Legislature if the passage of such legislation is to be avoided. Under the old methods of handling these matters, the smaller companies of a State were obliged either to ignore such injurious proposed legislation and trust to luck that it be not passed, or go to considerable expense and trouble to present their cases individually. The plan now in use in Wisconsin, and rather imperfectly carried out in some other States also, is for the association to employ some competent attorney to keep track of proposed legislation affecting electric railway and lighting companies and to present openly to the committees or to the individual legislators reasons why such legislation should not pass. The expense of maintaining this service by a competent attorney is borne by the various members of the association, and the cost is much less than if dependence were placed in the individual efforts of various companies. In many cases the managers of individual companies would take chances on the passage of a bill rather than go to the expense of a trip to Madison. Under the present arrangement no such chances need be taken as to obscure measures, as the association's attorney watches all legislation affecting its members.

At the first session, which was held Monday morning, June 28, Mr. E. W. Fairchild, of Milwaukee, the attorney who has handled the association's legislative matters for the past year, made a report on recent legislation in Wisconsin affecting public utilities. He said that but little legislation affecting such utilities had been passed the last session. The reason for this is that the public-utility law providing for the commission has solved so many of the problems which come up in connection with public utilities. Matters are now left to the commission which formerly would have been the subject of bills before the Legislature. He called attention to the large amount of work involved in keeping track of proposed legislation. Every bill must be read carefully sentence by sentence, because some overlooked paragraph or joker in a bill may be of great importance and may be passed by the Legislature without full knowledge of its intent. The most radical measures in Wisconsin now originate with what are called the "Socialist" members. While these

members are in the minority and cannot pass measures which are known by the name of "Socialist," their ideas find more favor than in former years, because of a gradual change in public sentiment.

Amendments to the Wisconsin public-utility law were made last session to cover the following points of interest to electric light companies: The time before which companies may voluntarily give up their franchises and avail themselves of an indeterminate franchise under the power of the commission, was extended from July 1, 1908, to Jan. 1, 1911. On the latter date the question may be reopened as to whether all companies shall be forced to give up their franchises and take indeterminate permits. Mr. Fairchild said that it looked very much as if such action would be taken in 1911. The Wisconsin commission is very much in favor of the indeterminate permit idea, on the grounds that a definite period of expiration of the franchise involves uncertainty as to the future of the property and necessitates higher rates than would be necessary if the company could continue to do business indefinitely on its good behavior.

Another change in the utility law makes it necessary to have a vote of the people in a city or town before any public utility can be purchased by the municipality. The law now makes prosecution of those caught stealing electricity easier than before, because it removes the value limitation previously imposed. The law regarding uniform rates to consumers has been modified so that a company can legally give a lower rate to a consumer who provides part of his equipment in the way of meters, lamps, etc., than to one who does not provide such equipment, but requires it to be furnished by the company.

In the discussion which followed, Mr. Fairchild was asked as to whether there seemed to be any likelihood that the present commission law of the State would be repealed, as there had been some agitation on that subject. Mr. Fairchild replied that be thought such a move extremely improbable. The movement against the commission originated in one town which failed to get reduced rates in a certain hearing, and had made but little progress. The Legislature and commission are working in very close touch and harmony, and the ideas of the commission on any subject are taken almost as law by the Legislature.

Mr. R. T. Gunn, general manager of the Eastern Wisconsin Railway & Light Company, Fond du Lac, read a paper on "Purchase of Coal on Straight Contract or Heat-Unit Basis," which will be printed in abstract in another issue, together with a discussion on that subject.

On Thursday morning Prof. Cyril M. Jansky gave a talk on the work which the University of Wisconsin is doing to spread scientific information of every-day use among those engaged in various industries. The old idea, he believed, was to cultivate culture simply for culture's sake, and that culture was only for gentlemen. To advance the welfare of a people scientific principles must be applied to all things industrial. Scientific knowledge must be made to permeate down among the masses. He then told of the Wisconsin university extension work which is being conducted to help men in various industries to learn more about the processes which they handle and to become instructed in the principles and so become more effective and useful members of society and better employees of the companies for which they work. These courses are carried on by correspondence and by occasional visits of instructors to places where classes may be formed. The general plan is to fit the work to the individual in each case, which, of course, involves much work by the instructors. The work is carried on by means of a State appropriation for the purpose, but a nominal fee is charged for tuition because people in general do not appreciate things which are free. The work differs from ordinary commercial correspondence-school work in that it is not a commercial or money-making scheme, being supported by the State.

Professor Jansky's remarks were received with much interest and appreciated by the managers present, and it appeared from the discussion that all prized the opportunities which this university extension work offers to men in the employ of the various companies who wish to become better posted along various lines of value to themselves and their companies. Mr. John S. Allen, of Lake Geneva, spoke specifically of having a boiler-room man who is looking for just this kind of instruction. Mr. Clement C. Smith suggested that where there is a group of properties or network of interurban lines, classes might be formed to meet at some central point. The question was then asked as to the effect on the men of such instruction and whether it did not soon result in their employment by other companies in better positions. The consensus of opinion and experience seemed to be that men who work diligently at correspondence or other courses are likely to become too valuable to remain in the same position long, but this was not considered an objection to the plan, but rather as a proof of its success. As one member put it, "We want the kind of men that are going ahead. We do not want men that no other company wants." Mr. R. T. Gunn said that the employees of his company had derived much benefit from a kind of instructional meeting which is held every two weeks.

Mr. Ernest Gonzenbach emphasized the point that there is really no place on an electric railway system for a purely unskilled laborer. Even the least skilled man of the lot who is worked along the track needs a certain amount of special knowledge, and the scale of wages should be such as to hold these specially good men. Considerable was said during the discussion about better instruction of men in the boiler-room. Mr. Gonzenbach thought that more intelligent men were needed in the car shop even more than in the boiler-room. Mr. C. N. Duffy expressed much appreciation of the address of Professor Jansky and of the university work of which he spoke. He thought the point should be strongly emphasized that the greatest work that the university can do is in the instruction of the unskilled laborer. The more men there are who leave operating companies because they are too good for the companies the better it will be for all of the companies. All that had been said about need for better knowledge in the boiler-room equally applied to the common worker in the accounting department.

In closing Professor Jansky called attention to the university's six weeks' summer school for artisans, in which those taking correspondence work can come to the university and have the advantages of the regular laboratories and learn laboratory methods. Nearly everything can be learned by correspondence except knowledge of laboratory methods and apparatus, and this can be obtained in the six weeks' summer course.

Mr. Ernest Gonzenbach gave a talk on "Desirable Kinds of Business," an abstract of which will be given in another issue.

Another Large Mexican Hydro-Electric Plant.

Manuel Cuesta, of Guadalajara, who is at the head of the Chapala Power & Irrigation Company, which has just been organized with a capital stock of $8,000,000 Mexican money, says that the hydro-electric plant which the company will construct for the purpose of providing water for irrigation will cost more than $2,000,000. It is probable that two of these power plants will be built—one to be located on the Santiago River near Guadalajara and the other on a stream that empties into Lake Chapala. Transmission lines will be built to operate the pumps which will be located upon the shore of Lake Chapala, the water of which will be used to reclaim 75,000 acres of land. The Government loan of $3,000,000 which was recently made to the company is secured by a lien upon the land that is to be reclaimed on a basis of $100 per acre. An additional loan of $2,000,000 has been made the company by the Caja de Prestamos, or Loan Bank, of this city. This money will be used to build about 110 miles of main irrigating canals, and to establish three pumping stations. While the first unit of this great system of irrigation will provide for the reclaiming of 75,000 acres of land, the plans when completely rounded out will involve the irrigation of more than 500,000 acres. The Pimintel interests of the City of Mexico, which own the street railway, light and power systems of Guadalajara, are associated with Mr. Cuesta in the enterprise.

Convention of the American Institute of Electrical Engineers.

General Report of the Proceedings at Frontenac, New York, June 28 to July 1, 1909.

THE twenty-sixth annual convention of the American Institute of Electrical Engineers, held at Frontenac, June 28 to July 1, was one of the most pleasant in the history of the Institute, in this respect ranking with the meeting at Great Barrington, Mass., in 1902. As the distractions incident to meetings in large centers were absent, the sessions had a full attendance, and the discussions were fairly complete. The total registered attendance at the convention was 252. Abstracts of all of the papers presented, grouped according to subjects, and of the following discussions, will be found elsewhere in this issue.

MONDAY MORNING, JUNE 28.

The convention was opened by President L. A. Ferguson at 10 a. m. Monday, June 28, who then delivered his presidential address, an abstract of which was printed in these columns last week.

The president-elect, Mr. Lewis B. Stillwell, New York, was then escorted to the platform. He replied in a brief speech, touching upon the continuity of the Institute organization and the steady development illustrated by the six changes in the constitution during the past 25 years. These changes show that the Institute is a progressive body. There never was a time when a professional and scientific organization had a better chance to impress itself upon the world of industry. Manufactured products doubled in the 10 years ending in 1907 in the United States, while electrical products doubled in the five years ending then. The Institute has now about 600 members and 6000 associates. As the art advances, new opportunities develop, and new specialties enter the field. How to dignify the organization and how to facilitate the interchange of views among specialists is a problem. Mr. Stillwell then emphasized the importance of the electrical engineer's taking some part in community affairs, to help secure proper national developments and to ward off projected adverse legislation. The engineer is often too busy to take much part in the details of public affairs, but they are none the less important; they bear directly upon the welfare of the individual, and deserve more attention in the future. Thus, at the recent Congress on Waterways, held in Washington, there was little evidence of an engineering character presented to show the financial savings in the cost of handling transportation by water. In conclusion the president-elect said that proper education is a subject close to the hearts of Institute members; that the demand of the times is for men who are capable of doing real engineering work, rather than for "intellectual mechanics," who can be hired in any number for small salaries. Broader training in the English branches is essential. Unless an engineer can present the facts in a clear and comprehensive way his schemes are not likely to be carried out by those who control the funds. A large part of the time of the modern engineer is expended in presenting projects and recommendations to boards of directors and committees in responsible charge of expenditures. Unless these recommendations can be properly presented it is difficult to secure the necessary appropriations.

The first paper on the program was "The Connection of Heat from Small Copper Wires," by Messrs. A. E. Kennelly, C. A. Wright and J. S. Van Byleveld. Dr. Kennelly abstracted this, and a discussion followed which was participated in by Prof. Vladimir Karapetoff, of Cornell University; Dr. C. P. Steinmetz, of Schenectady, N. Y.; Mr. Charles F. Scott, of the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., and Mr. Paul M. Lincoln, of the Westinghouse Company. The discussion centered around the terminology of the paper and possible vitiating conditions bearing upon the experiments. In general, the paper showed a remarkable difference in the radiation and connection losses in relation to free and forced connection, and the possible bearing of the quantitative results secured upon the measurement of air velocities, together with the influence of such investigations upon dynamo design were considered.

Mr. E. F. W. Alexanderson then read his paper, "Alternator for 100,000 Cycles," which was briefly discussed by Messrs. J. B. Taylor, J. C. Lincoln, D. B. Rushmore, Carl J. Fechheimer and A. E. Kennelly. The changes in design of several forms of this machine were considered, with precautions against trouble at high speeds.

The next paper was by Mr. L. W. Chubb, on a "Method of Testing Transformer Core Losses, Giving Sine-Wave Results on Commercial Circuits." It was discussed by Dr. Frederick Bedell, Cornell University.; Dr. C. P. Steinmetz; Dr. M. G. Lloyd, Washington, D. C.; Messrs. L. T. Robinson, Schenectady, and Charles F. Scott, Pittsburgh. The discussion centered on the advantages and the limitations of the core loss voltmeter described in the paper.

The next paper was on "The Testing of Transformer Steel," by Messrs. M. G. Lloyd and J. V. S. Fisher. It was discussed by Messrs. L. T. Robinson, V. Karapetoff, C. F. Scott, for C. E. Skinner, Tinker and E. E. F. Creighton. Considerable difference of opinion existed as to the relative value of the various methods of testing magnetic material, with particular reference to checking results and the quantity of material desirable in each test.

MONDAY AFTERNOON.

The afternoon session was opened by Dr. M. G. Lloyd's concluding discussion of his paper on the "Testing of Transformer Steel," carried over from the morning session. He defended the accuracy of the methods described in his paper and maintained that by these the weight of the test piece could be cut down from over 20 lb. to 4 lb. He urged the development of any number of testing methods which could be found serviceable and concluded with a few brief remarks about the use of silicon steel in transformers.

Mr. F. Creedy then read in abstract his paper on "A Sketch of the Theory of the Adjustable Speed, Single-Phase, Shunt Induction Motor," and Mr. E. F. W. Alexanderson his paper entitled "Repulsion Motor with Variable-Speed Shunt Characteristics." Mr. Creedy's paper was an exhaustive consideration of the theory of the machine, and it included a succinct review of the experiments of Mr. F. Punza and himself, also those of Dr. Alfred Fraenckel. He concluded that the problem of building high-frequency motors reduces to that of building high-speed commutators. An 8-pole, 60-cycle machine could probably be built to run successfully up to 2000 r.p.m. if equipped with a mechanically good commutator, and it would not be much more expensive than the compensated single-phase induction motor running near synchronism. The efficiency would be rather low, however.

Mr. Alexanderson said that the shunt repulsion motor is capable of a speed variation of 3 to 1 with armature control and 1.5 to 1 with field control; it is simpler than the three-phase shunt repulsion motor in its control, and its power factor is susceptible to the same sort of regulation as in the case of the synchronous motor. The work of Milch in compensating for power factor was fundamental. Mr. Alexanderson also gave a résumé of the principles of this motor.

The above papers were discussed together briefly by Messrs. Alexanderson, Creedy and Karapetoff. The first speaker complimented Mr. Creedy upon his review of the subject, while Mr. Creedy sketched a number of typical motor connections upon the blackboard and took up their salient features. Professor Karapetoff was not quite satisfied with Mr. Creedy's terminology.

The paper, "Heating of Induction Motors," by Mr. A. Miller Gray, was read by title only, in the absence of the author. This paper described methods of calculating heating losses in advance of their occurrence and reinforced the discussion with a considerable number of tests in actual practice. There was no discussion of this paper.

Mr. S. B. Charters, Jr., and Mr. W. A. Hillebrand's joint paper on "Reduction in Capacity in Polyphase Motors Due to Unbalancing in Voltage" was then read by Mr. Charters, in abstract. The paper submitted a number of tests on induction

and synchronous motors, showing the effects of phase shifting and voltage unbalancing. The authors concluded that unbalancing is likely to become of increasing importance as transmission and distribution networks extend. The paper was discussed by Messrs. R. E. Hellmund, Abell, A. M. Dudley, J. C. Parker, C. P. Steinmetz, C. F. Scott and H. L. Wallan. The general opinion was that the design of the motor is fundamentally important in fixing its behavior under unbalancing, and that first-class machines will stand a moderate amount of unbalancing without much trouble. The commercial importance of balanced circuits to hydro-electric power companies was mentioned, with the penalizing clauses sometimes incorporated in power contracts. It was also shown that sometimes the regulation of the motor may be the limiting condition rather than the heating.

Prof. A. S. Langsdorf then abstracted his paper on "The Current Losses of the Single-Phase Induction Motor." By vector diagrams and resulting equations the author maintained that the current losses of this machine is a true circle, and not a curve of the higher order, as frequently claimed. Prof. V. Karapetoff discussed the paper, emphasizing the value of Ferrari's assumption of two fields revolving in opposite directions in conceiving this subject from the pedagogical point of view. He also criticised the author's equations as more complex than necessary.

The final paper of the afternoon was abstracted by Mr. H. G. Reist, joint author with Mr. H. Maxwell, the title being "Multi-speed Induction Motors." The authors discussed the advantages of changing the number of poles by different methods, and presented diagrams for motors connected in concatenation. The paper was discussed by Messrs. H. C. Specht, A. M. Dudley and C. P. Steinmetz. It was shown that there is little to gain by concatenation, from the standpoint of practical design. The session adjourned with a general feeling of satisfaction that the highly specialized topic of the induction motor in its latest developments had been given a thorough airing; that the modified forms of this well-established machine bid fair to meet the more immediate commercial requirements of the near future; and that much further progress may be looked for in the development of alternating-current motors for variable speed service. There was a strong undercurrent of appreciation of the importance of this line of work to the general power world, although the commercial side of the case was not directly treated at any length by the designing engineers who attended the session.

MONDAY EVENING.

On Monday evening the south parlor of the Hotel Frontenac was the scene of a brilliant throng of convention members and guests, including many handsomely gowned ladies and their more soberly clad escorts. The occasion was a reception by the higher officers of the Institute and their wives to the delegates and members present. Music was furnished by the hotel orchestra of five stringed instruments and light liquid refreshment was served in an adjoining ante-room. The receiving line included Mr. C. W. Stone, chairman of the convention committee; President and Mrs. L. A. Ferguson, President-elect and Mrs. L. B. Stillwell, Vice-President and Mrs. James G. White, and Vice-President Calvert Townley and mother. After the reception dancing was enjoyed by many of those present. During the evening there were many informal reunions of friends from different parts of the country who chanced upon each other in the hotel or on the beautiful grounds of the Island. Several private yachts anchored at the pier also lent an added charm to the evening.

TUESDAY MORNING, JUNE 29.

Tuesday morning opened clear and cool, in pleasing contrast to the weather of the preceding week, and the first event was the departure at 10 o'clock of a great majority of the ladies for a steamer trip of about 2½ hours among the islands. The course extended from Frontenac down the river to a point near Alexandria Bay. Many of the gentlemen accompanied the party. The various points of interest along the route were announced by an official for the benefit of those taking the trip, and all voted the affair most enjoyable.

The business session began promptly at 10 o'clock, and the morning was devoted to the general subject of transmission phenomena. Mr. Percy H. Thomas first read his two papers in abstract, "Output and Regulation in Long-Distance Lines" and "Calculation of the High-Tension Line." They were discussed by Prof. Thos. R. Roseburgh, Dr. A. E. Kennelly, J. B. Taylor, Prof. D. C. Jackson, Dr. C. P. Steinmetz, P. M. Lincoln, R. D. Mershon, Prof. J. B. Whitehead and Charles F. Scott. Opinions differed considerably as to the comparative ease of calculation with Mr. Thomas' equations and with those submitted by Professors Roseburgh and Kennelly. The use of hyperbolic functions was recommended, but it was conceded that the tables of these functions are still somewhat lacking in completeness from the standpoint of the alternating-current engineer. Mr. Thomas disclaimed special mathematical skill in reviewing his papers, but there was a general disposition to dispute this. A note was sounded as to the importance of such calculations in the great power projects which are sure to come in the future, and stress was laid upon the surpassing importance of the so-called minor factors in transmission, as the voltage and distance increase. It was plainly evident from the discussion that the calculation of line phenomena in detail is a problem for the specialist, although approximate calculations can be made to a fair degree of commercial accuracy by the general engineer.

Mr. J. B. Taylor then abstracted his paper, "Even Harmonics in Alternating-Current Circuits." It was discussed briefly by Messrs. Frederick Bedell, C. F. Scott, Karapetoff and Steinmetz. Professor Bedell stated that the effect of direct current in a transformer is less than is generally realized. The other speakers touched upon the method of cancelling even harmonics, experience with transformers and the constancy of hysteresis losses in spite of unsymmetrical waves, so long as the height of the cycle remained fixed.

Prof. J. B. Whitehead then read his paper, "The Resistance and Reactance of Armored Cables," in abstract. Calculations and measurements were presented. There was no discussion, and the session adjourned.

TUESDAY EVENING.

On Tuesday evening an enthusiastic meeting and dinner were held in one of the hotel private dining-rooms by the officers of the Institute and the delegates from the different sections to the convention. A golf tournament began in the afternoon and in the evening a women's bridge whist tournament was held, the winners being Mrs. J. M. Wakeman, New York, and Miss Alice A. Reed, Newark, N. J.

The only evening session of the convention was held at 8 o'clock on Tuesday. The first paper was read in abstract by Mr. W. S. Moody, joint author with Mr. G. Faccioli, the subject being "Corona Phenomena in Air and Oil, and Their Relation to Transformer Design." A considerable number of interesting experiments were described, and the authors concluded that the subject will have to be studied still further in relation to transformer design for very high potentials. The paper was discussed by Prof. J. B. Whitehead, and Messrs. J. C. Lincoln, R. D. Mershon and S. B. Charters, Jr. The general opinion was that the subject offers a fertile field for investigation, with relation to different conditions. In small test circuits the amount of energy thus dissipated is scarcely measureable by any ordinary apparatus, it is so slight.

Mr. S. D. Sprong, joint author with Prof. E. E. F. Creighton, then abstracted his paper on "Surges on Cable Systems with Aluminum Cell Protection." The paper gave a large number of oscillograms and comments upon some surge experiments on the underground circuits of the United Electric Light & Power Company of New York in 1908. The discussion was carried on by Mr. J. L. R. Hayden, Mr. H. W. Fisher, Mr. J. B. Taylor, Mr. R. W. Mershon, Dr. C. P. Steinmetz and Prof. E. E. F. Creighton. The authors were complimented for taking the risk of such experiments, and in general, the value of the aluminum cell arrester was conceded. In closing Professor Creighton

gave an outline description of the forms which this arrester takes in modern manufacturing.

Mr. J. L. Woodbridge next abstracted his paper, "Split-Pole Converters and Storage Battery Regulation." He described the latest application of this character at the Gary plant, and showed that the improved voltage regulation increases the steel plant output per day. The paper was discussed briefly by Mr. D. B. Rushmore and Mr. Edward Van Wagenen, who emphasized the several fluctuations of load in rolling mill service.

The concluding paper of the evening was abstracted by its author, Mr. H. W. Fisher, the title being "Losses, Induced Volts, and Amperes in Armor and Lead Cores of Cables." A large number of interesting tests were presented, showing the increased losses in single-phase, alternating-current, armored cables under different conditions. The paper was discussed by Messrs. R. D. Mershon, Prof. J. B. Whitehead, and Dr. C. P. Steinmetz. It was shown that single-phase armored cables are undesirable except in special cases, where the runs are extremely short or other conditions are favorable. The session then adjourned.

WEDNESDAY MORNING, JUNE 30.

Two simultaneous sessions were held on Wednesday morning, one in the banquet hall and the other in the women's dining-room of the hotel. The former was devoted to the recent triumphs of electricity in the steel mill and the latter to problems of circuit measurement, dynamo and fuse designing. In the industrial meeting, the first paper abstracted was by Mr. C. T. Henderson, on "Electrical Control of Rollling Mill Motors." He described the recent advances in control which have made successful steel mill practice possible by electrical methods, showing the need of continuous service, the importance of instantaneous interchangeability, and the character of control required in special steel mill machinery. President Ferguson announced that all the steel mill papers would be discussed together, to save time and to broaden out the scope of the meeting.

Mr. H. E. White then abstracted his paper on "Automatic Motor Control," discussing the modern methods of contactor working, with circuit diagrams. Mr. B. Wiley abstracted his paper, "Power Requirements for Rolling High-Carbon Steel of Small Section," giving a large number of valuable test data. Mr. H. C. Specht abstracted his paper, "Function of Flywheels in Electrically Driven Rolling Millls." Mr. R. Tschentscher then presented a written discussion of the development of the Illinois Steel Company at South Chicago in the past 10 years from an electric power rating of 160 kw to 26,000 kw in 1909, and reviewed some of the requirements of the steel mills in electrical engineering. He also cited an interesting application of synchronous condensers to improve the power factor on an 11-mile line. The papers of Messrs. E. W. Yearsley on "Rolling Mill Motors," and E. Friedlander, on "Electrically Driven Rolling Mills," were abstracted by Mr. D. B. Rushmore.

The steel mill electrical papers were discussed by Messrs. J. C. Reed, D. B. Rushmore, C. F. Scott, K. A. Pauly, J. C. Parker, H. C. Specht, A. M. Dudley, H. E. White, J. B. Taylor, C. T. Henderson and W. L. Abbott. The remarks of a reflected great enthusiasm for the future of electricity in this field, which is likely to develop enormous power requirements. It was suggested that the central station and the steel mill may find it advantageous to co-operate. The value of the output in the steel mill is so great that the cost of apparatus is relatively unimportant. Intensified production at lower unit cost is the issue being solved by electricity in steel making.

WEDNESDAY AFTERNOON.

On Wednesday afternoon a vigorously fought baseball game was played by two nines umpired by Prof. G. F. Sever, of Columbia University. The teams were called the "Has Beens" and the "Never Wases." The battle was won by the "Never Was" aggregation, the score being 21 to 20. An enthusiastic and appreciative row of "fans" of both sexes lined up on the field to cheer the plays. Hard hitting and frequent bases on balls were the features of the game. The pleasures of the national game were supplemented by the semi-finals of the golf tournament, which offered attractions to large numbers of spectators.

WEDNESDAY EVENING.

On Wednesday evening an informal education dinner was held, at which Dr. C. P. Steinmetz was host and Prof. Dugald C. Jackson master of ceremonies. It was attended by about a score of men associated with collegiate engineering work, and a brief discussion of the curriculum question was presented by Messrs. Karapetoff, Jackson, Magnusson, Brooks, Scott and Steinmetz.

A searchlight excursion, with music and refreshments en route, was taken Wednesday evening on the steamer *St. Lawrence* by a delegation of about 150 ladies and gentlemen. The total convention registration on this day reached about 250 net. After the searchlight trip a dance was held in the hotel.

THURSDAY MORNING, JULY 1.

The final session of the convention was held on Thursday morning, and practically the entire time was taken up in the discussion of educational problems. Dr. C. P. Steinmetz and Mr. C. R. Dooley read their papers upon the "Value of the Classics in Engineering Education" and the "Training of Non-Technical Men." As might be expected from the great breadth of the subject, many diverse opinions as to the best character of training were presented in the discussion. Those who took part were Prof. C. A. Adams, Mr. C. F. Scott, Mr. Farley Osgood, Dr. M. G. Floyd, Mr. J. C. Parker, Mr. D. B. Rushmore, Dr. C. H. Sharp, Mr. J. G. White, Prof. G. F. Sever and the authors. The general opinion seemed to be that Dr. Steinmetz's recommendations in regard to Greek and Latin were somewhat radical; that a more thorough study of English is essential, and that Spanish is a desirable adjunct in American engineering education. It seems clear that many different kinds of education are needed. Dr. Steinmetz struck a high note in closing, when he stated that the production of engineers who are also broad-minded, intelligent citizens of the Republic is what is needed.

Mr. F. B. Jewett's paper on "The Modern Telephone Cable" was not read on account of the author's absence. The final paper, "Pole Face Losses," by Messrs. C. A. Adams, A. C. Lanier, C. C. Pope and C. O. Schooley was briefly abstracted by Professor Adams. It was very highly praised by Dr. Steinmetz.

A pleasant feature of the morning was the presentation of a past-president's badge to President Ferguson by Mr. D. B. Rushmore, for the directors.

The convention adjourned at 1:15 p. m., and with the finals in the golf tournament in the afternoon the twenty-sixth annual meeting of the Institute passed into history as one of the most successful and enjoyable ever held.

LOCAL SECTIONS.—Under the presidency of Mr. Paul Spencer, chairman of the committee on local sections, a dinner of the sections was held on Tuesday evening, June 29, when over 40 participated in a very full and frank discussion of the duties and possibilities of the Institute in regard to this important feature of its work. The dinner lasted over three hours, and earnest speeches were made by Messrs. Spencer, Ferguson, Whitehead, D. C. Jackson, Koiner, Magnusson, Peck (Atlanta), Troy, Rushmore, Steinmetz, Nichols, R. W. Pope, C. F. Scott, Hale (City of Mexico), Stillwell and Abbott. It had been intended to make the affair brief, and to adjourn to the regular evening session, but the deep interest manifested made this impossible. President Ferguson urged a more active initiative on the part of the sections, rather than a dependence on the work of the headquarters or of visiting engineers. The local section chairman should encourage interest by having papers read by good local men. There were too many different overlapping organizations, however, in the various localities; and he instanced what had been done in Chicago to prevent waste, duplicate effort of this kind. Mr. Abbott, of Chicago, gave a very interesting account of this work. Dr. Steinmetz made a strong plea in favor of "technical" sections, as a means of stopping disintegration and disruption into a number of smaller

bodies. President-elect Stillwell made a deep impression with a thoughtful speech along the lines of conservatism. He favored a "quality" Institute rather than a "quantity" one. Dilution and large number were not always the main factors for useful work. There was an American tendency just now to get over-organized, and it hardly seemed possible to carry out all the plans for more local sections, technical sections, and inter-sections without getting into confusion and more lost motion than ever. He approved heartily the plan fostered by President Ferguson for a secretary of sections, and endorsed by the council. This should remove many conditions of dissatisfaction and serve as a general stimulus. The dinner was attended by Past-Presidents Sprague and Martin and Vice-President J. G. White and Messrs. Townley, Lincoln, Brooks, Stone, Percy Thomas, Carlton and Rushmore, of the board. Twenty-five sections and branches were represented.

The Convention Committee this year consisted of Messrs. C. W. Stone, chairman; A. W. Berresford, W. A. Burke, S. Hosmer, J. W. Lieb, Jr., J. C. McQuiston, D. F. Schick, A. M. Schoen, S. D. Sprong, E. Wheeler, J. G. Wray, L. S. Streng. The burden of the work fell on the robust shoulders of Mr. Stone, and too much praise cannot be awarded him and his associates for the general completeness and success of the arrangements. Everything went smoothly from start to finish, and as one member said, "it was just like a large and well-managed house party." The glorious weather of the whole week contributed largely to the success of every event and entertainment.

Past-Presidents.—It is the custom of the past-presidents of the Institute and the present incumbent to meet once or twice a year and discuss society matters informally. This year the following past-presidents attended: Messrs. Martin, Kennelly, Scott, Steinmetz, Sprague, and on Wednesday morning they were met at breakfast by President Ferguson, and Mr. Stillwell, the president-elect. Dr. Kennelly was unfortunately called away on Tuesday evening. Mr. Scott, who had distinguished himself as a fisherman, provided a splendid catch of pickerel and bass for his colleagues, who sat in earnest converse for about three hours, during which very few points in Institute policy were overlooked.

Convention Sports.—During the week there were various contests which excited great interest and for which a number of beautiful prizes were provided. The list of events and prize winners is as follows: Cards, Mrs. J. M. Wakeman, first prize, gold-enameled pin with pearl setting; second, Miss Alice A. Reed, gold barpins in enamel and pearls. Golf driving contest, Prof. C. A. Adams, first prize, score 28, silver cigarette box; C. W. Stone, second, score 27, silver match box. Golf putting contest for ladies, Mrs. L. A. Ferguson, first prize, silver card case; Miss A. A. Reed, second, gold enameled belt buckle, tie between Mesdames W. I. Slichter, H. G. Reist and E. E. Donohoe, won in the play-off for third prize by Mrs. Donohoe, topaz hat pin. In addition a solid silver card case pencil was presented to each of the numerous contestants. Handicap golf tournament, F. E. Donohoe, best gross score, mahogany humidor; Frank P. Cox, best net score, silver Gillette razor set; Louis A. Ferguson, runner-up, small cut-glass decanter; A. I. Totten, winner, large decanter. Fishing contest, John H. Finney, winner, largest fish, silver flask; Frank H. Gale, largest catch of game fish, set of smoking pipes. The prizes were all on view at the hotel and were presented to the winners before the convention disbanded.

Interludes.—A delightful piano recital was given by Prof. V. Karapetoff, of Cornell University, in one of the parlors of the Hotel Frontenac during the afternoon of Wednesday, June 30. The Tuesday daylight excursion for ladies was largely patronized, and the attractions of the trip among the Islands were so strong that many gentlemen took advantage of the occasion. On Wednesday evening about 165 convention delegates, members and ladies, enjoyed a two-hour searchlight trip on the St. Lawrence River. Music and light refreshments were provided on the steamer, and the party sang college songs and had a merry time generally. On the return to Frontenac an informal dance was held. During Wednesday afternoon the "Has Beens" and the "Never Wases," captained respectively by Messrs Wagner and Gray, had a startling game of baseball, which the "Nevers" won by one run with a score of 21 piled up in six innings. Professor Sever was umpire and Ellery Paine scorer.

Press Representatives.—The *Electrical World* was represented at the meeting by Messrs. J. M. Wakeman, T. C. Martin, H. S. Knowlton and O. A. Kenyon.

Educational Dinner.—An informal dinner was enjoyed in the ladies' café on Wednesday evening by members whose professional work lies along educational lines. It was presided over by Dr. Steinmetz, while Prof. D. C. Jackson acted as master of ceremonies. Both spoke, as well as Professors Karapetoff and Magnusson and Mr. C. F. Scott. Over a score participated in the affair. The remarks made were addressed to the subject of the education of electrical engineers.

Employees' Saving Fund of Commonwealth Edison Company.

The Commonwealth Edison Company, of Chicago, has adopted a plan for the creation of an employees' saving fund which became effective on July 1. Any employee of the company who has been in its service for one year or longer may become a subscriber to this fund. He will then pay into the fund during a subscription period of five years an amount equal to 3 or 5 per cent of his salary, as he may elect. At the end of the subscription period the subscriber or his estate will receive back all money contributed by him with interest compounded semi-annually at the rate of 6 per cent; but if before the five years has elapsed the subscriber elects to discontinue his subscription agreement while still employed by the company his rate of interest will be reduced from 6 per cent to 4 per cent. If the subscriber resigns or is discharged before the expiration of the five years, he will receive his money back, with 6 per cent interest. But if a subscriber fails to make three or more payments when due, his interest will be reduced to 3 per cent during that year.

If the subscription period continue for the full five years the subscriber may exercise an option to receive, instead of cash, the same amount in the company's capital stock at par, if the stock of the company is then selling at or above par, or at the average market price during the two preceding months if the selling price of the stock is then below par.

This is a really generous offer on the part of the Commonwealth Company, and at the price the stock of the company is now selling means a return to the subscriber of a trifle less than 16 per cent per annum. For instance, if a subscriber puts in $2 a month for a period of 60 months, at the end of that time he can receive in cash $139.80, being his principal ($120) with interest at 6 per cent compounded semi-annually. Should he prefer stock, however, as would naturally be the case, the company will issue to him stock having a par value of $139.80. As Commonwealth Edison stock is now selling at about 120, this would mean that the market value of the subscriber's investment would be $167.76. Thus, the increment of the subscriber's deposit of $120 would be $47.76. As the average amount on deposit during the five years would be $60, the return on this, $47.76, would make the interest on the deposit reach the rather surprising figure of a trifle less than 16 per cent a year. This is on the supposition that the stock is selling at 120 at the end of the period. Subscribers, it will be seen, have an incentive to make the stock so valuable that it will sell in the public market at a premium. But in any event the depositor is guaranteed 6 per cent, whereas the rate in Chicago savings banks is 3 per cent. In addition, the saving would be made with absolute safety in all human probability. The subscriber is furnished a pass-book resembling those issued by savings banks.

The Commonwealth Edison Company has about 2500 employees, with a payroll of $2,000,000 a year. Between 1500 and 2000 of these will be eligible to subscribe to the fund. The scheme was worked out by a committee of heads of depart-

ments and was adopted by the directors of the company practically without change. About 200 applications for admission to the fund were received on the first day. The committee in charge of the fund, appointed by the board of directors, consists of Mr. Samuel Insull, president of the company; Mr. Edward L. Brewster, director; Mr. Benjamin Carpenter, director; Mr. Louis A. Ferguson, second vice-president; Mr. J. H. Gulick, construction superintendent; Mr. W. L. Abbott, chief operating engineer, and Mr. P. Junkersfeld, electrical engineer. The officers of this committee are: Chairman, Mr. Insull; secretary, Mr. John F. Gilchrist; treasurer, Mr. Wm. A. Fox; auditor, Mr. John H. Gulick. Careful rules and regulations governing the fund have been drawn up with the aid of legal counsel, and the plan seems to be one which will be heartily welcomed by the employees of the company.

Wisconsin Rate Commission News.

A suit was instituted in the Circuit Court of Kenosha, Wis., on June 28, which has for its purpose a test of the public utilities act of the State. The suit was brought in the name of the State at the instigation of the Kenosha Gas & Electric Company against the Kenosha Electric Railway Company, for the purpose of prohibiting the railway company from accepting any privileges granted to it under a franchise for a system of electric lighting recently passed by the City Council. Previous to the passage of the ordinance the Kenosha Gas & Electric Company surrendered its franchise and accepted in lieu of this an indeterminate permit from the State. The railway company secured no permit from the State Railroad Commission nor did it ask for a certificate of necessity and convenience. The State holds that under the law no franchise could be granted by the City Council to the street railway company.

The fiscal year of the Railway Commission closes on June 30 and the annual reports of all the utility companies operating in the State must be closed upon the same date. The commission has prepared a special form of report for each kind of utility and all reports must be filled out and returned to the commission not later than August 1, except in the case of those smaller companies that have received special dispensation. These report forms are very complete and are designed to contain every detail of information which could possibly be of value to the commission in fixing rates or in adjudging the adequacy of service, and at the same time to introduce a uniform system of accounting. The commission's system of accounting, while apparently very complex, is in reality very simple on account of its systematic arrangement. The majority of the companies have found little trouble in changing from their systems to the commission's. But the call for such a detailed report has brought to light a woeful lack of knowledge in many cases concerning the most important items of economic station management, and the necessity of obtaining the data called for will go a long way toward putting such stations on an intelligent working basis.

In Milwaukee, on June 25, a hearing was commenced in the case of the city of West Allis against the Milwaukee Electric Railway & Lighting Company. The street railway company has been charging double fare from the city of Milwaukee to the city of West Allis, a suburb of Milwaukee. West Allis is a manufacturing center and the majority of the men employed there reside in Milwaukee. Because of the double fare, the plaintiff claims that, when times are good, it is difficult to obtain labor, for the workingmen seek naturally to obtain employment within the most convenient distance of their homes and where the facilities for getting to and from work are the best. Many of the men now walk from 6 to 15 blocks in order to reach the one-fare limit. This condition of affairs, the plaintiff asserts, is very seriously affecting the growth and prosperity of West Allis and a one-fare rate is asked for.

The Wausaw Electric Railway Company has petitioned the commission for a rehearing in regard to the schedule of rates recently ordered by the commission.

The Cumberland Telephone Company was granted authority to increase its rates on business telephones from $1.50 to $2 per month. The Cumberland Telephone Company had combined with a competing company which had gained entrance to the city. After examining the balance sheets of both companies and considering the added service accruing to the subscribers as a result of the combination, the above increase in rates was ordered. This is, however, a tentative order pending a valuation of the companies' property.

The Midway Telephone Company petitioned for an increase in rates on business telephones from $1.25 to $1.50. The company operates two exchanges and it is proposed to connect them and give the subscribers the benefit of both exchanges. As the higher rate was already in force at one of the exchanges the commission ordered it put into effect at the other also.

Space Between Passing Street-Railway Cars.

An end has been made, apparently, to the agitation in Chicago relating to the space to be left between passing street-railway cars. At a meeting of the Board of Supervising Engineers on June 29 resolutions were adopted to the effect that the distance between track centers should be extended from 9 ft. 8½ in. to 10 ft. 2 in. for all new work which has not progressed so far that it is impracticable to make the change. Further, it is given as the judgment of the board that all future cars to be built for operating on the surface lines of Chicago shall not exceed 8 ft. 6 in. in width over all. As the present pay-as-you-enter cars are 9 ft. wide, this decrease in width of the cars and increase between track centers will increase the width between passing cars from 8½ in. to 20 in.

Mr. Bion J. Arnold, chief engineer of the board, has issued a statement in which he says that 20 in. between passing cars is the greatest space that can be provided practically in Chicago with the standard 38-ft. roadway. He points out that even this distance of 20 in., however, cannot be obtained upon tracks already reconstructed nor so long as the present wider cars are operated. He says that it is only fair to the representatives of the Chicago City Railway Company to state that the purchase of its present 9-ft. cars was approved by the full board and that that company remains firmly of opinion that fewer accidents will occur if the present narrow space between cars be uniformly maintained. Mr. Arnold himself concurred in this opinion at one time, but on further investigation he believes that the wider space will at least give a person caught between passing cars a chance for his life.

Invention in Electric Welding.

Mr. J. A. Hunnewell, the general superintendent of the Lowell Electric Light Corporation, of Lowell, Mass., directs our attention to an opportunity for invention or improvement in the field of electric welding. An inquiry has reached his company which he refers to as follows: "The welding of steel edges to iron backs in the manufacture of chippers and planing knives certainly offers a wide field for electricity. The single concern in which we are interested is building two other plants in other parts of the country. This firm is thoroughly interested in electric welding, and if some electrical concern is interested enough to investigate the field, it will find the proprietors of the plant willing to go more than half way in overcoming the obstacles. We have been unable, as yet, to find any concern which either has entered or is willing to enter this field.

"The process of welding is at present somewhat as follows: Steel strips about 2 in. wide and ⅜ in. thick and varying in length from 4 in. to 50 in. are laid along the edge of iron backs which are 6 in. or 8 in. wide and about 1 in. thick. In this position they are placed in a gas-heated furnace and then put through hammers and rolls, this process being repeated several times for the same knife. Both the large chippers and the small planers are made in a similar manner. There is no uniformity in the size of the product as conducted at present, but this could probably be arranged to a considerable extent."

New York Public Service Commission News.

The prospect for new subways in New York seems very bright at the present time. On June 30 the Public Service Commission received a definite offer from the Interborough Rapid Transit Company proposing the construction of subways and elevated tracks to an extent involving an expenditure of between $75,000,000 and $100,000,000. These plans contemplate a four-track subway down the Seventh Avenue route from Times Square to Canal Street with a two-track line from there to the Battery; the third tracking of the Ninth Avenue elevated from Fourteenth Street to Battery Place; a two-track subway under Canal Street over the new Manhattan Bridge to connect with the present subway at Nevins Street, Brooklyn; the third tracking of both the Second and Third Avenue elevated lines and an extension of the former to bring its tracks all the way to the Brooklyn Bridge; the sale of the Steinway tunnel to the city, at cost, with the guarantee of a 5 per cent fare from its eastern terminus to any point in Manhattan reached by the Interborough's lines; the building of a spur from the Second Avenue elevated over the Queensboro Bridge with a five-cent fare; the construction of a two-track express subway under Third Avenue and a two-track local subway under Lexington Avenue from Forty-sixth Street north to the Harlem River and the extension of the present elevated structure from 155th Street and Eighth Avenue across the Macomb's Dam Bridge and up Jerome Avenue to 194th Street. The commission has taken no action on these proposals, but it is not at all likely that they will be approved. The commission has already adopted the modified Broadway-Lexington Avenue route originally authorized by the Rapid Transit Commission and is not inclined to depart from that plan. It is pointed out that the proposals of the Interborough do not carry out that plan but take up pieces of the routes at different places so as to effectually block any other company from constructing the line. The Interborough is willing that its elevated and its subway proposals be considered as separate propositions, but it makes the purchase of the Steinway tunnel a necessary feature of the subway plans. The total amount of new track involved in the plan is about 68½ miles and it is the Interborough's suggestion that the city bear a considerable portion of the expense. It also wants franchises that will be parallel to those now held by its subway and elevated lines.

In the meantime the Public Service Commission is prepared to act independently of all formal proposals. The Board of Estimate and Apportionment has granted the request of the commission, and authorized it to advertise for bids for the construction and operation of the subway and elevated lines adopted in 1906 by the old Rapid Transit Board. Specifications for the plans and forms of contracts for these bids are now being prepared and the advertisements will soon be published. This course will bring all the rival interests to one point. If they want to build subways they must bid under the commission's plan and the commission will have then the option of placing the work where it will be most advantageously done for the city or of accepting some of the proposals that have been made to it.

The South Flatbush Railroad Company has withdrawn its application to the Public Service Commission for permission to construct a rectangular line from Avenue Q station on the Brighton Beach elevated line to Flatbush Avenue giving as a reason that the company is to be reorganized and after this is done amended plans will be filed.

The Public Service Commission, by a unanimous vote, has decided that the Coney Island & Brooklyn Railroad Company is justified in charging a 10-cent fare on Sundays and holidays, but that it should charge only five cents on other days. The company has let it be known that this expression on the part of the commission will make no difference in its present plan of charging two fares all the time and that it will fight the reduction in the courts if necessary. The ruling of the commission was made after receiving the report of Bion J. Arnold, its engineer, that the physical value of the road was $5,000,000.

The Public Service Commission for the Second District has denied the application of the Niagara Falls Lighting Company for authority to exercise rights and privileges granted to it by the city of Niagara Falls, under which the company proposed to enter the lighting field in opposition to the company now giving service in that city. The reasons given for the refusal are that the evidence did not disclose that the existing lighting system was so inadequate or inefficient as to justify the introduction of a competing plant. The existing company has stipulated to the commission that it will reduce the price of arc lamps from $65 to $52 per year, the latter amount required by the commission.

Alleged Interference with Telegraph and Telephone Operation by a Single-Phase Railway.

The new Chicago, Lake Shore & South Bend Interurban Railway, between Chicago and South Bend, Ind., is a single-phase road 77½ miles long, with operating potential on the trolley wire of 6600 volts. Passing around the southern end of Lake Michigan it parallels for a long distance the Lake Shore steam railroad and the wires of the Western Union and Postal telegraph companies. The steam railroad and the telegraph companies allege that their telegraph and telephone service has been seriously interfered with by induction from the high-potential, single-phase trolley wires of the railway company. They seek to enjoin the Interurban people from operating their cars on the ground that the high voltage has demoralized by induction their methods of electrical communication. As previously noted in these columns, the judge who was asked to issue the injunction refused to do so, holding that no company has a monopoly of the air. The telegraph companies and the steam-railroad company have now taken an appeal to the Supreme Court of Indiana, so that the matter remains undecided. The Lake Shore steam railroad uses the telephone to a considerable extent to supplement the telegraph in transmitting train orders, and it declares that the operation of the 6600-volt overhead-trolley circuit by single-phase, alternating current is a serious hindrance in the use of both its telephone and telegraph wires.

Magnetic Tests of Common and Silicon Steel.

A circular issued under date of June 1 by the Bureau of Standards, Washington, on the subject of magnetic testing, sets forth the scope of the Bureau in this line of work, and includes a description of the methods employed and a schedule of fees. Two tables are printed in the circular which give the results of the magnetic tests of ordinary steel and of silicon steel. It is pointed out that ordinary sheet steel in common use varies very widely in its magnetic qualities, and that the quality is not closely related to the cost. While the watt loss when tested with alternating current varies in the case of ordinary steel from 1.25 to 2.36 watts per pound for sheets of No. 29 gage, at a frequency of 60 cycles and a magnetic induction of 10,000 gausses, silicon steel varies only from 0.66 to 1 watt per pound under the same conditions. In addition to this variation there is a great difference in the constancy of magnetic properties with time. Some metals show very decided aging, which in one case amounted to as much as 67 per cent in 500 hours; other specimens, including most silicon steels, show little or no variation with use.

As to the commercial significance of the tests, the design of a 5-kw transformer is taken for an illustration. If instead of material showing a core loss of 45 watts another showing a core loss of 32.2 watts is taken, the saving in operation for 8760 hours, or one year, amounts to 112 kw-hours. At a cost of 1 cent per kw-hour this amounts to $1.12, which at 10 per cent, allowing for depreciation as well as interest, represents a capital of $11.20; in other words, the buyer could, with advantage, pay any amount up to $11 more for the sake of getting better material in his core, and the manufacturer could pay 28

cents per pound more for the 40 lb. of material used. If the better silicon steel were to cost 2.8 cents more than the other (which is improbable) the difference in cost of the steel would be $1.12, and the user would each year save 100 per cent of extra cost.

The comparison between the power silicon steel and the ordinary steel is even more marked. In a case cited the difference in core loss would be the equivalent of $2.45 per year, thus practically reducing the value of the transformer by $24.50; yet the difference in cost of the material is only $1.70 if the price of silicon steel delivered at the factory is taken at 7½ cents per pound and that of ordinary steel at 3¼ cents per pound, assuming 40 lb. to be necessary.

CURRENT NEWS AND NOTES.

SAN FRANCISCO VOTES AGAINST MUNICIPAL OWNERSHIP.—By a popular vote San Francisco has decided against a municipal underground-conduit surface electric railway. A two-thirds vote was necessary to carry the measure, which was defeated by 403 votes.

CINCINNATI "DAYLIGHT" ORDINANCE.—On July 1 Acting-Mayor Galvin, of Cincinnati, approved an ordinance whereby clocks in that city will, it is hoped, be set back one hour from May 1 to Oct. 1, thus giving "one more hour of daylight" to those who rise an hour earlier.

HALF MILLION FOR ROSE POLYTECHNIC.—The Rose Polytechnic Institute of Terre Haute has received a bequest of one-half million dollars by the will of the late Susan Frances Heminway, one of the chief heirs of Mr. Rose, founder of the school. In addition, Mrs. Heminway leaves the Rose homestead, an entire block in the heart of the city, for the use of this school.

EDISON STORAGE BATTERY.—In a newspaper interview, Mr. Thomas A. Edison has announced that he has finally completed his storage battery. He stated that he had been working on the problem for years, and four years ago thought he had solved it, but was too cautious to make positive announcement of a victory then. Now he says he has absolutely no doubt of triumph.

NIAGARA DAM.—The International Waterways Commission, which has been investigating the practicability of constructing a dam across Niagara River to raise the water level of the Great Lakes, has about finished its work, and the report, it is said, will be made next month. It is understood that a majority of both Canadian and American commissioners will recommend the building of the dam.

TELEGRAPH TIME-FILING LAW UPHELD.—The Court of Appeals of Maryland has upheld the constitutionality of an act passed at the last session of the Maryland Legislature requiring the time of sending and receiving every telegram to be placed upon messages sent from and to all points within the State. The case was brought up for review in an appeal by the Postal Telegraph Company against the State, a fine of $10 having been imposed against that company for having refused to obey the law.

SIXTY-CENT GAS IN INDIANAPOLIS.—Judge Anderson, of the Federal Court, sitting at Indianapolis, has denied an injunction asked by the Indianapolis Gas Company against the city and State to prevent the enforcement of a 60-cent gas rate. The court refused to consider any of the allegations of the company, saying that it had two years and four months in which to go into court, and that it was unfair to wait until within two days of its expiration. Judge Anderson also citicised the company plan to furnish gas on a sliding scale at 60 cents per thousand to large users, raising to 90 cents to small consumers. According to the new law the Indianapolis Gas Company must in the future sell gas at 60 cents per 1000 cu. ft.

QUAINT DEFINITIONS.—In the course of a recent talk on railroad electrification before the Electric Club, of Chicago, Mr. E. N. Lake took occasion to allude to two amusing definitions that he had found in an old book published in New York in 1818 and entitled "The New York Expositor," being, among other things, "A collection of the most useful words in the English language." In this little work are these two definitions: *Electricity*—A property in bodies whereby, when rubbed, they draw substances and emit fire. *Engineer*—One who manages engines or directs artillery.

TESLA ON WIRELESS.—In a recent newspaper interview Nikola Tesla stated that it would soon be possible for a business man in New York to dictate instructions and have them instantly appear in type in London and elsewhere. He will also be able to call up from his desk and talk with any telephone subscriber in the world, the only means to this end necessary being an inexpensive instrument no bigger than a watch. Similarly any kind of picture, drawing or print can be transferred from one place to another by wireless. As to the transmission of power without wires, he said that he has been experimenting with a motor boat operated by wireless power, and the results indicate that ocean liners may be propelled across the Atlantic Ocean at high speed by power sent from a wireless station on shore.

READINESS-TO-SERVE RATE UPHELD IN COURT.—At the recent meeting of the Canadian Electrical Association, Mr. G. S. Chambers, of the Truro, Nova Scotia, central station, gave an account of litigation following the adoption of the readiness-to-serve system of rates. About two years ago the Nova Scotia Legislature passed an act instituting Government control of rates, and just prior to its enforcement the Truro company filed a new rate schedule under which a readiness-to-serve charge was established of 10 cents per 16-cp lamp for the first nine lamps connected, with 3 cents for each additional lamp, together with a meter charge of 10 cents per kw-hour, less 10 per cent for cash. The legality of this system of rates was contested through the various courts up to the Supreme Court, the contention being that readiness-to-serve could not be made the basis of a charge. All of the courts sustained the central-station schedule.

LIQUEFIED GAS.—A consular report gives some information in detail concerning the manufacture of liquefied gas, sometimes known as "Blau gas," as carried on under the Wolf process near Zurich. It is stated that a factory equipped for this process will be erected in Boston. The liquefied gas is sold in cylinders containing 20 lb., 40 lb. and 80 lb. each at 15 cents per pound. The liquid gas is obtained by the dry distillation of raw petroleum and of by-products of the lignite and oil industries. The raw materials are decomposed in retorts by the action of a high temperature; the vapors and gases produced then pass through the tar separators and the cleaner, losing here the easily condensable gases (tar, benzine, etc.), as well as any deleterious and malodorous by-products that may be present. by means of patented apparatus, and the use of cold and pressure, a separation of the difficultly liquefiable gases, such as hydrogen, methane, etc., from the more easily liquefiable ethane, propane, pentane, etc., is obtained. These are then liquefied, carbureted and filled into steel transport cylinders provided with a valve and sold as "liquid gas." It is easily transportable and utilizable and has a high illuminating and heating power. The report states that the liquefied gas is used in a number of towns supplied with electric lighting plants.

PENNSYLVANIA ELECTRIC ASSOCIATION.—The next convention of the Pennsylvania Electric Association will be held at Eagles Mere, Pa., Sept. 8, 9 and 10, 1909. Mr. E. L. Smith, of Towanda, Pa., is secretary of the association.

DRUDGERY OF TRUDGERY.—A recent jingling catch-line to advertise the telephone service is embodied in the announcement that "Telephonia" is emancipating the world from the "drudgery of trudgery." The Chicago Telephone Company is making use of this phrase in some of its advertising matter.

OHIO ELECTRIC RAILWAYS.—According to information secured for the United States Commissioner of Corporations, the subscribed working capital of the electric roads of Ohio is $150,000,000. Capital of steam roads operating in the State is about $725,000,000. This information was secured from returns under the Willis and Cole tax laws and does not include any of the corporations that are delinquent.

CANADIAN ELECTRICAL ASSOCIATION CONVENTION.—In our issue of June 24 a report in part was given of the annual convention of the Canadian Electrical Association, accompanied by a statement that a supplementary report would appear in a following issue. We regret that, owing to a complication that arose in connection with arrangements for reporting the meeting, this promise cannot be fulfilled.

OHIO ELECTRIC RAILWAY PUTS ON THROUGH FREIGHT TRAINS.—Arrangements have been made by this company to run through freight cars between Toledo and Dayton by way of Lima and Springfield. Only through business from Toledo and Lima will be taken on these cars. It is said that the business has grown beyond expectation and that the company has arranged for the additional facilities in order to take better care of the freight that is offered for through shipment between these points.

REFINING STEEL ELECTRICALLY.—In a paper presented before the Faraday Society on electric furnaces as applied to the manufacture of iron and steel, M. Charles A. Keller stated that the results obtained with electric furnaces of his design in operation at the Holtzer Steer Works at Unieux, indicate that a 20-ton, three-phase furnace of 1800 kw could now be constructed. Such a furnace could purify 250 to 300 tons of steel per day, supplied by a Thomas converter, at an operating cost of $3 to $4 per ton, with electrical energy at 0.3 cent per kw-hour obtained by utilizing blast-furnace gas.

ELECTRIC TRACTION IN FRANCE.—At last the constant agitation of the subject by engineers has produced an effect upon one of the main railroad lines of France, which will now undertake a large scheme of electrification. The Chemin de Fer du Midi has just given out the first contracts for a project which includes 400 km of its main track from Bordeaux to Toulouse The work will be divided among the more important manufacturing companies. This installation will be single-phase, 15 cycles, and the first section should be in operation about a year hence. It is believed that the action of this railroad will help in crystallizing other projects in France.

HARD-DRAWN COPPER WIRE SPECIFICATIONS.—At the meeting in Philadelphia last week of the American Society for Testing Materials, a committee of the body presented a set of standard specifications for hard-drawn copper wire. The specifications, which were accepted and ordered to be sent out for letter ballot by members of the society, comprise 18 sections, four of which apply to grooved trolley wire and five to cable or stranded wire. Determinations of electric conductivity are specified to be made at 20 deg. C. (68 deg. Fahr.), and the following maximum limits imposed: For diameters 0.460 in. to 0.325 in., 900.77 lb. per mile-ohm; for diameters 0.324 in. to 0.040 in., 910.15 lb. per mile-ohm.

ILLINOIS TUNNEL COMPANY'S TELEPHONE FRANCHISE.—Final disposition of the matter of extending the telephone franchise of the Illinois Tunnel Company, in Chicago, was made for the present by the Chicago City Council on June 28. The tunnel company was given until June 1, 1911, to install the 20,000 telephones required by the terms of its franchise; further, it may not sell its telephone franchise before Jan. 1, 1911, to any purchaser except the Chicago Telephone Company. This action was taken so that the proposed merger may be before the Council in June, 1910, when the possible revision of telephone rates of the Chicago Telephone Company under the ordinance by which the latter company operates will come up.

ELECTRICAL CLOCK.—The English electrical journals describe an electrical clock known as Kutnow's 1000-day clock. The clock derives its motive power from a single dry cell, the current from which is utilized to energize periodically a small electromagnet carried by a balance wheel. The base-plate of the clock is of iron, and it is the mutual attraction between this iron plate and the electromagnet attached to the balance wheel which furnishes the energy necessary to drive the clock. Contact is made and broken at regular intervals by a suitably disposed contact spring, and the balance wheel is controlled by a reacting spring similar to the hair-spring of a watch. The oscillations of the balance wheel in either direction represent one second.

PROPOSED RICHMOND (VA.) MUNICIPAL PLANT.—The proposed Richmond (Va.) municipal lighting plant, for which large appropriations have been made, will in all probability require considerably more money than was first anticipated before the system is fully provided for. The first additional matter is in relation to lighting all of the alleyways of the city, and cost of the same. The appropriations, it is said, do not include the overhead work, nor the electric light line, both of which will be expensive items, only the machinery and power plant being included in the heretofore published estimates and awards. The city will be compelled to build a complete system of street electric lines to replace the old system which has been used under lease from the old Virginia Passenger & Power Company. The city has declined to purchase these lines, poles, wires, etc., desiring to put in a new system. To date the money available by bond issues is $250,000 for construction purposes and $100,000 for machinery in the lighting power plant.

BOMB EXPLOSION IN CHICAGO CAUSES TELEPHONE DAMAGE.—Considerable excitement was caused in Chicago by an explosion supposed to be due to a dynamite bomb in a manhole of the Chicago Telephone Company near the Central exchange, in the rear of 100 Washington Street, on June 27. So far as the telephone company was concerned, the principal force of the explosion was downward, and a number of cables were broken. Windows were also broken in the building containing the exchange, but the wire-glass used in these windows prevented much damage here and demonstrated its efficiency. Considerable damage was done to surrounding buildings and several persons were injured. The identity of the persons placing the bomb is unknown, but as there have been several previous explosions of this character in Chicago, the affair has attracted a great deal of attention, and the City Council has directed the Mayor to offer a reward of $3,000 to any person or persons who may furnish the police department information that will lead to the arrest and conviction of the perpetrators of the outrage. To this amount the Chicago Telephone Company has added a further reward of $2,000, making a total reward of $5,000. In view of some statements in the daily press hinting that the Electrical Workers' Union, with which the company has had some difficulty, may have had something to do with the explosion, it is proper to add that both Mr. A. S. Hibbard, vice-president and general manager of the company, and the business agent of the union, unite in scouting any such suspicion as absurd.

Electrical Features of the New Northwestern Railroad Terminal in Chicago.

WITHOUT doubt the most important construction work now under way in Chicago is the new passenger terminal of the Chicago & Northwestern Railway, work on which is actively in progress. This undertaking involves the building of an entirely new terminal for a great railroad system, and it will represent an expenditure of about $20,000,000 or more. While the tearing down of old buildings on the site and the new structural work has been under way for several months, plans for the generation and application of electricity have only recently been decided upon, and, indeed, some of the details are still to be worked out. A brief general account of the electrical features will be given herewith.

The premises covered by the new terminal station comprise about four city blocks and consist essentially of the terminal station building, the train sheds (with baggage-rooms, cab and automobile stands, emigrants' quarters, etc., beneath the tracks) and the power house. These structures will be erected in the space bounded by Milwaukee Avenue on the north, Canal Street on the east, Madison Street on the south and Clinton Street on the west. This space is traversed by Lake Street, Randolph Street and Washington Boulevard, which are east-and-west streets, the greater dimension of the terminal site being from north to south. These three streets will cross the terminal in subways, the tracks of the terminal being carried on an elevated structure.

FIG. I.—MAIN ENTRANCE CHICAGO & NORTHWESTERN RAILWAY PASSENGER TERMINAL, CHICAGO.

The terminal station proper will front on Madison Street. It will be an imposing building of granite with one story on the street level, one on the track level and two upper stories for offices and rest rooms. This station building occupies the greater portion of the city block bounded by Madison, Canal and Clinton streets and Washington Boulevard. The first or ground floor is approximately 18 ft. in height. Above this on the track-level floor is the main waiting-room, 100 ft. x 200 ft., with a total height of 82 ft. to the apex of the vaulted ceiling. Around this main waiting-room is a ledge which is 46 ft. from the floor. Surrounding the waiting-room is a gallery or second floor, and likewise a third floor, both being divided into offices and various rooms for station purposes. The fourth story is devoted to locker-rooms and storage space. The building fronts 320 ft. on Madison Street, running north on Clinton and Canal streets a distance of 272 ft.

North of this building the train sheds extend practically to Lake Street, a distance of about 900 ft., with a width throughout of 320 ft. These sheds are substantially the same as those of the Lackawanna terminal at Hoboken, N. J., having low roofs with an opening in the roof above the center line of each track. The locomotive stack is in line with this opening, so that all gases are exhausted directly into the air above the sheds. Sixteen tracks will be used for through passenger and suburban service, and on each of these tracks two ordinary trains may be accommodated at one time. In other words, each of the 16 tracks has a capacity for 13 Pullman coaches or 16 day coaches. The new terminal will have facilities for handling 250,000 passengers daily and the area covered by it will be about 13 acres, while practically 10 acres of floor space will be devoted to public use.

Between Washington Boulevard and Randolph Street there is provided a suburban concourse. This is 50 ft. wide and extends from Clinton Street to Canal Street underneath the overhead steel structure. Stairways lead to each of the platforms above, each platform serving two trains. All of the remainder of the space below the track structure will be occupied by outgoing baggage-rooms, emigrants' quarters, mail and express-rooms, automobile and cab stands and private carriage and bus driveways. The concourse for the through passenger service is on the track level and connects the station building proper with the train sheds.

POWER HOUSE.

All of the electricity for lighting and power purposes will be generated in a power house placed in the triangular block north of Lake Street, bounded on the north and east by Milwaukee Avenue, on the south by Lake Street and on the west by Clinton street.

The boiler plant consists of three batteries of two boilers each. These are Babcock & Wilcox wrought-steel, vertical-header boilers, each containing 5000 sq. ft. of heating surface. The boilers are set high and are fired from what is usually considered the rear end. Each boiler is to be equipped with a Foster superheater designed to raise the temperature of the steam 70 deg. Fahr. above that due to a pressure of 155 lb. by gage. Green traveling chain-grate stokers are to be fitted to the boilers.

Coal will be delivered to the power station by cars run in on

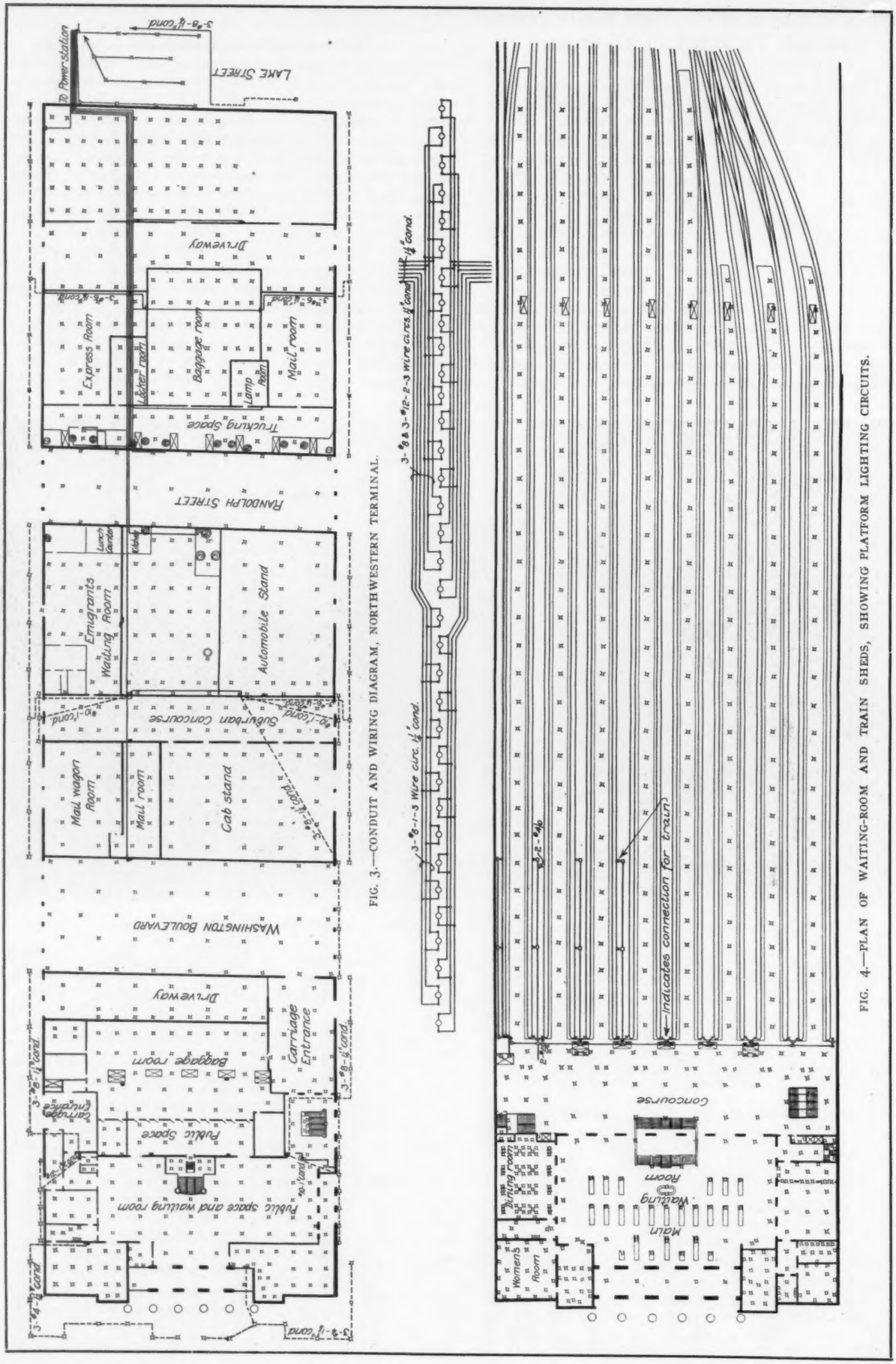


FIG. 3.—CONDUIT AND WIRING DIAGRAM, NORTHWESTERN TERMINAL.

FIG. 4.—PLAN OF WAITING-ROOM AND TRAIN SHEDS, SHOWING PLATFORM LIGHTING CIRCUITS.

ELECTRICAL FEATURES OF THE NEW NORTHWESTERN RAILROAD TERMINAL IN CHICAGO.

a spur track, below which has been provided three steel coal hoppers. From these hoppers coal is delivered through suitably arranged spouts to a traveling steel-belt conveyor which passes it to a crusher. This crusher in turn delivers the coal to a cross steel-belt conveyor, from which it is spouted to a pivoted-bucket conveyor, which carries the fuel to concrete coal bunkers overhead. The pivoted-bucket coal conveyor also is to be used for ashes. The refuse is delivered from the ash pits below the boilers into the conveyor, carried up to the top of the building and there dumped into a transverse steel-belt conveyor, which in turn delivers the ashes into a double compartment overhead bunker, whence they will be dumped into the empty cars on the spur track.

The chimney will be located at the northern angle of the triangular block. It will have a clear inside diameter of 11 ft. and will extend practically 250 ft. above the boiler-room floor. The base of the chimney will be square to a height of about 40 ft. Above that there will be a circular shaft built of radial brick. Two lightning rods will be attached to the chimney. These will be connected at the top to four or six platinum-coated points. The point rods on the top of the chimney will be of solid round copper bar ⅝ in. in diameter and about 6 ft. high, securely fastened to the circuit with bronze slide connections. The conductors to ground will be placed on opposite sides of the chimney, each one extending 20 ft. into moist earth and grounded with a copper plate. Each conductor will consist of a rope-laid standard copper cable having a cross-section of not less than 254,000 circ. mils. The ground plates will be round, 7 in. in diameter, ½ in. thick, and provided with suitable holes, to which will be fastened the ends of the conductors. The breeching and the boiler uptakes will be made of very heavy sheet-steel plate. This breeching will extend over the top of the boilers at the rear and beneath the coal bunkers, and at the north end will enter the reinforced-concrete breeching, which is extended on a curve through the north end of the boiler-room wall into the base of the chimney.

In the engine-room there will be three vertical, cross-compound, non-condensing Allis-Chalmers engines rated at 1200 ihp under guaranteed steam consumption of 19 lb. per indicated hp-hour with steam at 150 lb. pressure by gage and 60 deg. superheat. To each will be direct-connected a 750-kw, 250-volt, direct-current General Electric generator turning at 100 r.p.m. Space is provided for a fourth unit.

One of the most interesting features of the power plant is the fact that there has been provided a 500-kw horizontal Rateau exhaust-steam turbine made by the Western Electric Company and directly connected to a 250-volt direct-current generator made by the same company. Space is left for the addition of a future exhaust-steam turbine unit. This turbine unit is guaranteed to develop a kw-hour on 43.5 lb. of steam at full load, this steam being delivered to the turbine at 16 lb. absolute pressure (1 lb. pressure by gage) with a vacuum of 27 in. in the exhaust chamber. The turbine speed is 1500 r.p.m. The unit is guaranteed under normal operating conditions to vary but 2 per cent between no load and full load. Momentary variation in speed due to sudden changes in load is not to exceed 4 per cent. The generators of the steam-turbine unit will be operated in multiple with the engine-driven generators. It is well known that high-pressure steam can be used to best advantage in reciprocating engines and low-pressure steam in turbines. The principle of using the exhaust steam from non-condensing reciprocating engines in low-pressure turbines has been used in extending existing plants, but the power house under description appears to be the first in the country to install from the beginning an exhaust-steam turbine in series with non-condensing reciprocating engines.

The condensing apparatus used in connection with the turbine is to be furnished by Henry R. Worthington, the condenser being of the surface type, with centrifugal, circulating and hot-well pumps motor-driven. On the roof of the building above the boiler house will be located a cooling tower of the four-fan type, each set of fans having extended shafts and being driven by an electric motor. One portion of the power plant is underneath the elevated-track structure and here, extending east from the engine-room, will be located various auxiliary apparatus, such as the condensing machinery, air compressors, boiler-feed pumps, motor-generator sets, station balancer sets and some other machinery.

There are two motor-generator sets. They consist of direct-current motors driving 500-kw, 6000-volt, 60-cycle, three-phase generators for furnishing electricity to be used outside of the terminal station for lighting yards, freight houses, etc. Direct current also will be furnished from the power house for the operation of the new Northwestern bascule railroad bridge across the North Branch of the Chicago River connecting with the present Wells Street station. The electricity to operate the signal towers will also be supplied from this power house. The total initial generating capacity of the plant will be 2750 kw. The engine-room is to be equipped with a 25-ton, three-motor, overhead traveling crane manufactured by the Shaw Electric Crane Company.

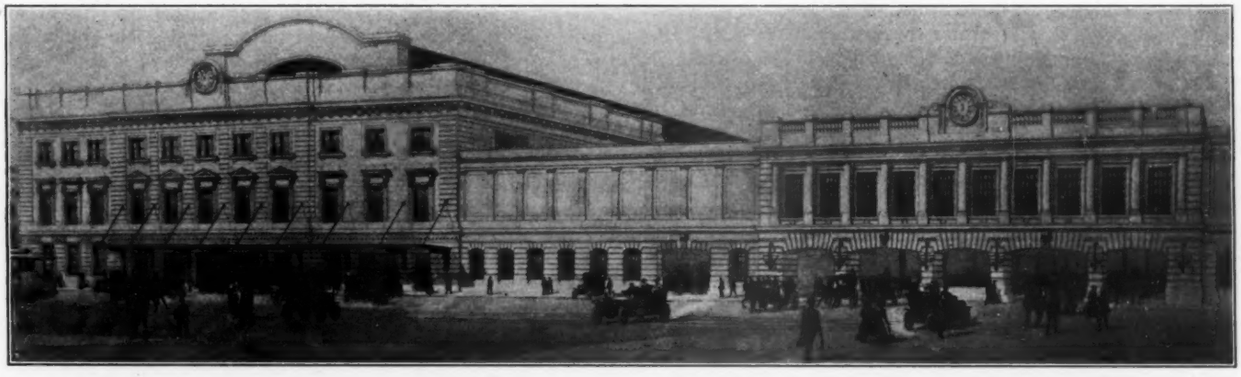


FIG. 2.—PORTION OF CANAL STREET FRONT, CHICAGO & NORTHWESTERN RAILWAY PASSENGER TERMINAL, CHICAGO.

The main switchboard in the power house will be placed on a gallery at the south end of the building. Cables will be carried through steel troughs in the elevated structure crossing Lake Street, from which point cables for delivering electricity to the main terminal station building will be carried through a vertical shaft to an overhead structure built above the train sheds, leading south to the station building and there dropping through a similar shaft to the basement of the building where they will connect to a distributing switchboard. Other cables for under-track service will be carried under the track structure, supported from the steel work.

In the block between Washington Boulevard and Randolph Street will be located three balancer sets. These will be of the same size—one for the three-wire distribution in the block between Randolph and Lake streets, another for the block in which the balancer sets are located, and a third being used as a relay set. In the basement of the terminal station building balancer sets will be provided to care for the unbalancing of the

lighting loads in that building. Another balancer set will be installed for lighting trains standing in the train sheds. Here also a relay unit will be provided.

Direct current on the three-wire system will be used both for lamps and motors throughout the terminal. It was selected rather than alternating current primarily on account of the number of motors requiring speed control. this being an essential feature of the extremely comprehensive ventilating system; further, while the elevators in the main terminal station building and the baggage lifts at the south end of the train sheds will be hydraulic, there will be eight baggage lifts north of Randolph Street which will be electrically operated. With direct current there will be less complication of machinery and appliances, simpler switchboard construction and easier manipulation of the switchboard, while no transformers or motor-generator sets will be required. The motor-generator sets previously mentioned will be used for providing alternating current to be used outside of the terminal. Preliminary proposals were received for both alternating-current and direct-current apparatus, and it was found that a saving of about $20,000 could be made by the use of direct current, making allowance for the increased amount of copper required. Taking all of these facts into consideration it was deemed that there was sufficient warrant for the installation of a direct-current plant.

LIGHTING FEATURES.

A comprehensive system of electric lighting has been provided in the station building and other parts of the terminal premises. The main waiting-room in particular will be supplied with ornamental standards and bracket fixtures around the wall of the great room, and in addition concealed lamps will be placed along the ledges on the north and south sides of the room, which will light by reflection from the vaulted ceiling the large open space of the lofty apartment.

In the train sheds lamps have been provided over the platforms and underneath the tracks the illumination will be ample for all requirements. To light the façade of the station building and also the sidewalks adjoining the terminal premises, ornamental posts with electric lamps will be provided for street lighting, forming a continuous line along Clinton, Madison and Canal streets and extending into Milwaukee Avenue. The Washington Boulevard, Randolph and Lake streets and Milwaukee Avenue posts are especially designed, those on Clinton and Canal streets being arranged for four incandescent lamps, three of which will be mounted in a downward position and one pointing upward. The posts on Madison Street will have five lamps, four pointing downward.

In addition to these posts, which will be placed on the curb line, there will be four beautiful, large, bronze lamp standards of massive and artistic design in front of the Madison Street façade of the terminal station building, two on each side of the main entrance. These handsome standards will form part of the architectural effect of the building and are clearly shown in Fig. 1.

Likewise shown in Fig. 1 are the two clock towers on the Madison Street front, and there will also be street clocks on the train-shed walls on Clinton and Canal streets over the Washington Boulevard subway. All of these clock dials will be especially illuminated by means of light reflected from large steel disks, somewhat larger in diameter than the dials themselves and placed immediately back of the dials. The lighting will be done by incandescent lamps placed in a trough surrounding the disks. The light is first reflected onto the disk, from which it is further reflected to the glass clock dial. As the main clock dials are over 11 ft. in diameter the trough containing the lamps has been made circular in shape and will revolve on rollers, so that it will be possible for the attendant, standing on the floor, to renew the lamps by simply turning the trough.

The lamps in the main waiting-room, street-level waiting-room and in the subways, as well as all street lamps and clock-dial lamps, will be controlled from a central point in the terminal station building. It will be possible to switch these lamps in circuit in sections, the operation being by means of remote-control switches operated from a central point by momentary-contact push buttons. A similar arrangement is planned in the case of the train sheds, where the lamps will be arranged in long rows, each gateman having a small lockbox from which he can control the lamps on his own platform. The lamps are wired alternately and every other one of them or all may be used. The remote-control switches for this purpose are placed at the south end of the train sheds, the particular advantage in this case being that while the power house is at the north end of the terminal premises, the control is at the extreme south end.

One unusual feature will be the installation of two 18-in. projectors on the Canal Street side of the train sheds, one over Washington Boulevard and one over Randolph Street. From these projectors vertical beams of light will be thrown into the air, and these will serve to make the terminal location conspicuous at night, guiding the traveler, particularly if a stranger in the city, on his way to the station. The beams of light will be visible for a long distance and will be particularly useful inasmuch as the traveling public has, for many years, been familiar with the Wells Street location of the Northwestern railroad station. The beacons of light will give a visual manifestation, not to be mistaken, of the change in location.

Another interesting characteristic of the lighting service is the means provided for lighting trains that are standing in the sheds. The train-lighting service is operated at 110 volts, and each train will take approximately 25 kw. A special set of feeders has been provided for this service, arranged on the three-wire, 220-volt system connected to a balancer set. From this balancer, which is placed in the terminal station building, three wires are run to and along the train sheds near the line of the bumpers. Each track is provided with a panel board located on the ceiling of the train shed, on which are placed magnet switches controlled by the electrician in charge of the train-lighting service, by means of momentary-contact push-button switches placed in cast-iron cases on the bumper posts.

These push-button switches are arranged in connection with the magnet switches, so the operator may throw in a particular train one either side of the three-wire circuit. For indicating the condition of the line before the particular train is thrown in, a shunt has been provided in the neutral before connection is made to the train-lighting bus, and from this shunt leads are run to small zero-reading ammeters located in each box with the push buttons.

Ordinarily connection for lighting service for trains standing in sheds is made from the platform level at the bumper post or from service boxes at the track level. In the Northwestern terminal, however, a method has been provided for making this connection from an overhead winding cable properly encased and placed on a drum provided with a retrieving spring. These cable drums or spools will be placed over the bumper post of each track and also at intervals down the line of the track in the train shed, so that cars other than the end one may be reached. The electrician is provided with a short pole having a hook, by means of which he can reach the end of the cable and pull it down, and is thus able to make connection to the car. When disconnected the cable is wound up in much the same way that a Hartshorn shade roller is operated. This arrangement permits of connecting the cable to cars of varying lengths.

Cables of 2,000,000 circ. mil area are run from the power house to the terminal station building. These are to be provided with suitable switches so that any cable or pair of cables may be cut out during periods of relatively light load, thus resulting in obtaining close feeder regulation. There will be 12 of these cables altogether—eight for general lighting purposes, two for motor service and two for train lighting. The great part of the run of these cables from the power house to the terminal station building is made in the cableway previously mentioned as being on the roof of the train sheds. This cableway is of fireproof construction and is entirely enclosed. On this account, and also owing to the low voltage of the system, weatherproof wire is used, thus materially reducing the first cost

of the installation and also providing an installation in which depreciation is reduced to a minimum.

MOTOR AND MISCELLANEOUS SERVICE.

Including the north baggage lifts, of which there are eight, there will be at least 500 hp in electric motors installed throughout the premises. Motors will be used for driving heating and ventilating apparatus in the terminal station building and also for the centrifugal house pumps, the ejector sewage system, pneumatic-tube system and the dumb waiters; and in addition there will be electric motors installed for operating mail conveyors.

All elevators in the terminal station building, both passenger and baggage lifts, including a service elevator, are to be hydraulic, being driven by high-duty, steam-actuated pumps, the steam for which will be transmitted from the power house direct, a distance of 1500 ft.

The exhaust available from these pumps will be utilized for heating purposes during cold weather, and in the summer the greater portion of this steam will be available for heating water for use in the kitchen and restaurant and for the hot-water service in the building.

Intercommunicating telephone and fire-alarm systems have been provided. A special electrical signaling system will be used, by means of which the towerman can signal the gateman and the train conductors when a track is made clear for an outgoing train.

This signaling system has been ingeniously worked out so that by means of push buttons and electric light signals the towerman, train conductor and gateman keep in close touch with one another at the time of the departure of trains, to the end that there may be greater safety in dispatching the trains promptly on schedule time.

President Marvin Hughitt, of the Chicago & Northwestern Railway Company, devoted a large amount of his personal attention to the details of the mechanical and electrical equipment of this new passenger terminal. The direct charge of the work, however, is under the supervision of Mr. John M. Whitman, vice-president of the company, in charge of construction. All engineering details are passed upon by the chief engineer of the company, Mr. E. C. Carter. Frost & Granger are the architects for the railway company, and Pierce, Richardson & Neiler are the consulting and designing engineers. Mr. W. C. Armstrong is the terminal engineer in charge of all the structural work of the new terminal. The officers of the Northwestern company believe that the premises will be ready for occupancy early next year.

Power Characteristics of the Tungsten Filament.

BY CHARLES P. STEINMETZ.

As in the tungsten-filament incandescent lamp the resistance increases with the temperature, the power consumption varies at a rate which is less than proportional to the square of the impressed voltage. It, therefore, was interesting to investigate experimentally the manner in which the power consumption increases with increase of voltage.

In pursuit of an extended investigation on the radiation law of the tungsten filament, a series of tests had been made with special care on a number of modern tungsten lamps, extending over a wide range of candle-powers. Taking the readings very quickly, by experts especially trained in photometric work, it was possible to reach 10 times the rated candle-power of the lamps, without any appreciable impairment or change of the filament or blackening of the globes, as evidenced by the lamp showing its original candle-power and efficiency after the test. For these data the writer is indebted to Mr. F. C. Marshall, of the Harrison Lamp Works.

Analyzing the relation between the power consumption and the impressed voltage, the interesting result was found that the power consumption varies proportional to the 1.6 power of the voltage; that is, follows a law analogous to that of the hysteresis loss in iron in an alternating magnetic field, and thus can be expressed by the equation:

$$w = c\, e^{1.6}$$

The following table gives in the first four columns the observed values of candle-power L, impressed voltage e, and current i of one of these lamps, a 32-cp, 40-watt lamp. The fifth column gives the watts w derived by multiplying volts and amperes. The values of this column can be expressed by the equation

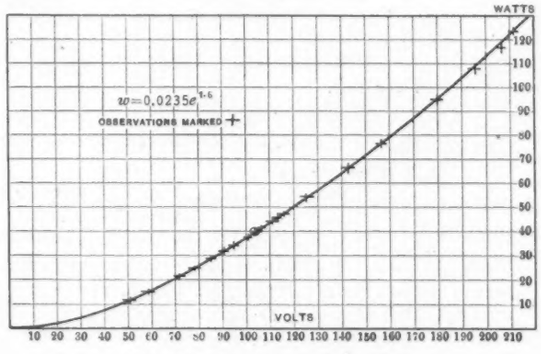
$$w = 0.0235\, e^{1.6}$$

In the sixth column of the table are given the values calculated by this equation of the 1.6 power, and in the last two columns, the differences between observed values of power w and values calculated by the 1.6 power law. As will be seen the difference in no case reaches 1 per cent.

No. of Test.	L CP.	e Volts.	i Amps.	w Watts.	Watts Calculated.	Difference.	%
1.....	2	49.6	.247	12.25	12.14	— .11	— .9
2.....	4	59.6	.274	16.33	16.26	— .07	— .4
3.....	8	70.6	.302	21.35	21.40	+ .05	+ .2
4.....	12	79.0	.324	25.60	25.55	— .05	— .2
5.....	16	85.3	.339	28.91	28.89	— .02	— .1
6.....	20	90.4	.350	31.64	31.70	+ .06	+ .2
7.....	24	95.7	.361	34.55	34.70	+ .25	+ .7
8.....	28	100.5	.371	37.29	37.47	+ .18	+ .5
9.....	32	103.3	.380	39.26	39.25	— .01	— .0
10.....	36	106.6	.389	41.47	41.30	— .17	— .4
11.....	40	110.9	.398	44.14	44.00	— .14	— .3
12.....	44	113.3	.401	45.42	45.50	+ .08	+ .2
13.....	48	115.6	.407	47.05	47.20	+ .15	+ .3
14.....	32	103.5	.380	39.33	.....	...	..
15.....	64	126.6	.429	54.31	54.40	+ .09	+ .2
16.....	32	103.6	.381	39.46	.....	...	..
17.....	96	142.9	.460	65.73	65.95	+ .22	+ .3
18.....	32	103.3	.380	39.23	.....	...	..
19.....	128	157	.489	76.77	76.68	— .09	— .1
20.....	32	103.4	.380	39.29	.....	...	..
21.....	192	180	.529	95.24	95.45	+ .21	+ .2
22.....	32	103.0	.380	39.14	.....	...	..
23.....	256	196	.556	109.00	109.4	+ .40	+ .4
24.....	32	103.2	.380	39.22	.....	...	..
25.....	288	206.5	.571	117.9	118.9	+ 1.00	+ .8
26.....	32	103.8	.381	39.55	.....	...	..
27.....	320	212	.580	122.9	124.0	+ 1.10	+ .9
28.....	32	103.8	.380	39.45	.....	....	+ .9

In the accompanying illustration is shown the curve of 1.6 power, with the observed values of power marked by crosses. As will be seen, the coincidence is so close as to give no noticeable deviation in the scale of the curve.

About 18 years ago the writer observed that the relation between the power loss in iron in an alternating magnetic field and the magnetic density can, with good approximation, be empirically expressed by a law of 1.6 power:



EXPONENTIAL CURVE, 1.6 POWER.

$$w = \eta\, B^{1.6}.$$

This law of hysteresis is still an empirical law, and all attempts to derive it rationally from theoretical considerations have thus far failed. It therefore is especially interesting to observe the same law of the 1.6 power, showing the relation between the consumption and voltage of tungsten lamps, especially as in the tungsten lamp the law of the 1.6 power is not only an empirical law, but can rationally be derived as a theoretical conclusion from the temperature law of metallic resistance,

$$r = a\, T,$$

and the normal radiation law,

$$R = b\, T^4,$$

where T = absolute temperature and R = total radiation power.

Complete Solution of Transmission Line with Distributed Capacity and Leakage.

By Harold Pender.

In transmission lines of considerable length and high voltage, the effect of the line capacity becomes quite appreciable. This effect is usually calculated by assuming that the capacity of the line is equivalent to two condensers, each of half the capacity of the line, one shunted across the line at the receiving end and the other shunted across the line at the generating end. As is well known, this assumption gives only an approximate solution.

The complete solution of a line with capacity and leakage has been given by a number of authors, but the formulas deduced are so complicated that few engineers attempt to use them, but accept the approximate formulas as sufficiently accurate for practical purposes. It is always well, however, to check an approximate formula when used for important work, and it is therefore highly desirable to have accurate formulas in a shape which can be readily applied.

It is the purpose of this paper to put these accurate formulas in the simplest possible shape for practical use, and at the same time to show how the formulas in question are derived. By introducing the power-factor angles of the line impedance and leakage admittance, the deduction of the formulas is greatly simplified, as well as the final formulas themselves.

The article is arranged as follows: First, the quantities involved are clearly defined, then the final working formulas are given; this is followed by a numerical example worked out both algebraically and graphically, and finally is given the deduction of the formulas.

SUMMARY OF WORKING FORMULAS.

To avoid the use of numbers of many figures, in the following definitions and formulas the line voltage is expressed in kilovolts, the leakage resistance in megohms and the capacity in microfarads.

Let V_o = kilovolts (thousands of volts) between each wire and neutral at receiving end.

I_o = amperes per wire at receiving end.

ϕ_o = power-factor angle of receiver ($\cos \phi_o$ = power factor of receiver).

These same symbols without the subscript "$_o$" refer to the generator end of the line.

$z = \sqrt{r^2 + x^2}$ = impedance of each wire per unit length, where r and x are, respectively, the resistance and reactance in ohms per unit length.

ε = power-factor angle of the impedance $\left(\cos \varepsilon = \frac{r}{z}\right)$

$y = \sqrt{g^2 + b^2}$ = leakage admittance of each wire per unit length, where g equals the reciprocal of the insulation resistance to neutral[1] in megohms per unit length, and $b = 2\pi f C$, where f is the frequency and C the capacity to neutral[1] in microfarads per unit length.

η = power-factor angle of admittance $\left(\cos \eta = \frac{g}{y}\right)$

l = length of line.

Calculate the following quantities (angles are represented by Greek letters and are expressed in degrees, the logarithm is to the base 10).

$$a = \sqrt{\frac{z}{y}} \qquad \text{and } S = 10^{-3} l \sqrt{y z}$$

$$\delta = \frac{\eta + \varepsilon}{2} \qquad \text{and } \gamma = \frac{\eta - \varepsilon}{2}$$

$\log k = 0.4343\, S \cos \delta$ (take k from table of logarithms).

$\mu = 114.6\, S \sin \delta$

$\theta_o = \phi_o + \gamma$.

$J_o = a I_o$

$$A = \frac{k}{2} \sqrt{V_o^2 + J_o^2 + 2 V_o J_o \cos \theta_o}$$

$$B = \frac{1}{2k} \sqrt{V_o^2 + J_o^2 - 2 V_o J_o \cos \theta_o}$$

$$\cos \beta_o = \frac{V_o^2 - J_o^2}{4 A B}$$ (take β_o from table of cosines).

β_o has the same sign as θ_o.

$\beta = \beta_o - \mu$.

$V = \sqrt{A^2 + B^2 + 2 A B \cos \beta}$

$J = \sqrt{A^2 + B^2 - 2 A B \cos \beta}$.

$$\cos \theta = \frac{A^2 - B^2}{V J}$$ (take θ from table of cosines).

θ has the same sign as β.

Then

Kilovolts to neutral at generator end is V.

Amperes per wire at generator end is $I = \frac{J}{a}$

Power factor at generator end is $\cos \phi = \cos (\theta - \gamma)$.

For a single-phase line the total kilowatts generated will then be $2 V I \cos \phi$, and for a three-phase line the total kilowatts generated will be $3 V I \cos \phi$.[2]

NUMERICAL EXAMPLE.

Length of line, 700 miles.

Power delivered, 40,000 kw, three-phase.

Voltage delivered, 150,000 volts; frequency, 25 cycles.

Power factor of delivered power, 0.918.

Resistance of each wire per mile, 0.085.

Reactance of each wire per mile, 0.3095.

Impedance of each wire per mile, 0.3215.

Capacity susceptance of each wire per mile, 2.386; no leakage.

$$V_o = \frac{150}{\sqrt{3}} = 86.6$$

$\cos \phi_o = 0.918$, therefore $\phi_o = 23.37°$

$$I_o = \frac{40{,}000}{\sqrt{3} \times 150 \times 0.918} = 167.7$$

$z = 0.3215$.

$\cos \varepsilon = \frac{0.085}{0.3215} = 0.2644$, therefore $\varepsilon = 74.67°$

$b = y = 2.386$

$\cos \eta = 1$, therefore $\eta = 90.00°$

Then

$$a = \sqrt{\frac{0.3215}{2.386}} = 0.3671$$

$$S = 10^{-3} \times 700 \sqrt{0.3215 \times 2.386} = 0.6131$$

$$\delta = \frac{90.00 + 74.67}{2} = 82.34°,$$

therefore $\cos \delta = 0.1334$ and $\sin \delta = 0.9911$

$$\gamma = \frac{90.00 - 74.67}{2} = 7.66°$$

$\log k = 0.4343 \times 0.6131 \times 0.1334 = 0.03552$

therefore $k = 1.0853$

$\mu = 114.6 \times 0.6131 \times 0.9911 = 69.64°$

$\theta_o = 23.37 + 7.66 = 31.03°$, therefore $\cos \theta_o = 0.8569$

$J_o = 0.3671 \times 167.7 = 61.56$

$$A = \frac{1.0853}{2} \times \sqrt{(86.6)^2 + (61.56)^2 + 2 \times 86.6 \times 61.56 \times 0.8569} = 77.55$$

$$B = \frac{1}{2 \times 1.0853} \times \sqrt{(86.6)^2 + (61.56)^2 - 2 \times 86.6 \times 61.56 \times 0.8569} = 21.38$$

$$\cos \beta_o = \frac{(86.6)^2 - (61.56)^2}{4 \times 77.55 \times 21.38} = 55.83$$, therefore $\beta_o = 56.06°$

$\beta = 56.06 - 69.69 = -13.63°$, therefore $\cos \beta = 0.9718$

[1] For either a single-phase (two-wire) line or three-phase (three-wire) line with wires symmetrically arranged, the insulation resistance to neutral is one-half the insulation resistance between any pair of wires, and the capacity to neutral is twice the capacity of the condenser formed by any pair of wires; this relation holds for lead-covered cables, as well as for overhead lines. Note, however, that, with respect to the triple harmonic, a three-phase line with grounded neutral should be treated as a single-phase line with the three conductors in parallel and the ground as the return, and that the insulation resistance and capacity should be determined for this condition.

[2] The above working formulas, in slightly different shape, were first published by the author in "Power Conductors," by W. A. Del Mar. (Van Nostrand.)

$$V = \sqrt{(77.55)^2 + (21.38)^2 + 2 \times 77.55 \times 21.38 \times 0.9718} = 98.46$$

$$J = \sqrt{(77.55)^2 + (21.38)^2 - 2 \times 77.55 \times 21.38 \times 0.9718} = 56.99$$

$$\cos \theta = \frac{(77.55)^2 - (21.38)^2}{98.46 \times 56.99} = 0.9905, \text{ therefore } \theta = -7.90°$$

(Note that in each pair of radical expressions the second differs from the first only in the sign before the third term; the numerical calculation of these quantities is, therefore, by no means as complicated as appears when the formulas are written out in full.)

Hence kilovolts between wires at generator end:

$$98.46 \sqrt{3} = 170.5$$

Amperes per wire at generator end: $\frac{56.99}{0.3671} = 155.2$

Power factor at generator end: $\cos(-7.90 - 7.66) = 0.9634$.

Since the power-factor angle at the generator is negative ($-15.56°$), the current at the generator is leading.

DERIVATION OF FORMULAS.

The derivation of the above formulas is given below; note that a uniform system of units is used throughout; the working formulas given above, involving the compound units, kilovolts, megohms and microfarads, are derived from the final formulas deduced by introducing the proper coefficients.

Let l = distance of any point on the line from the receiving end.

r = resistance of each wire per unit length.

L = self-induction of each wire per unit length.

g = leakage conductance between each wire and neutral per unit length.[1]

C = capacity between each wire and neutral per unit length.[1]

v = instantaneous value of pressure between wire and neutral at point under consideration.

i = instantaneous value of current in the line wire at point under consideration.

t = time.

At any point on the line we then have

$$\frac{dv}{dl} = ri + L\frac{di}{dt} \qquad (1)$$

$$\frac{di}{dl} = gv + C\frac{dv}{dt} \qquad (2)$$

Differentiating these equations with respect to l and remembering that $\frac{d}{dl}\left(\frac{dv}{dt}\right) = \frac{d}{dt}\left(\frac{dv}{dl}\right)$ and similarly that $\frac{d}{dl}\left(\frac{di}{dt}\right) = \frac{d}{dt}\left(\frac{di}{dl}\right)$ and noting that $\frac{dv}{dl}$ is given by equation (1) and $\frac{di}{dl}$ by equation (2), we get

$$\frac{d^2v}{dl^2} = rgv + (rC + gL)\frac{dv}{dt} + LC\frac{d^2v}{dt^2} \qquad (3)$$

$$\frac{d^2i}{dl^2} = rgi + (rC + gL)\frac{di}{dt} + LC\frac{d^2i}{dt^2} \qquad (4)$$

The coefficients of these two differential equations are identical, their integrals will, therefore, differ only in the constants of integration. The general integral of a differential equation of this form can be represented by a Fourier's series in which each term is of the form

$$A_0 e^{ml + ht} \sin(\omega t + nl + \alpha_0) \qquad (5)$$

where the constants are all real quantities.

Each of these terms represents a wave of frequency $\frac{\omega}{2\pi}$ and wave length $\frac{2\pi}{n}$ advancing along the line toward the generating end with a velocity equal to $\frac{\omega}{n}$; the amplitude of the wave at any point is $A_0 e^{ml + ht}$; the angle α_0 represents the phase of the disturbance at the receiver at time $t = 0$. If sufficient time is assumed to have elapsed after closing the circuit for the amplitude of the current and voltage at each point to have attained a constant value, the factor e^{ht} becomes unity (h is a negative quantity), and the above expression becomes

$$A_0 e^{ml} \sin(\omega t + nl + \alpha_0) \qquad (6)$$

Each term of this kind in the Fourier's series must satisfy the differential equations separately, since the differential equations are linear. Therefore, putting

$$v = A_0 e^{ml} \sin(\omega t + nl + \alpha_0) \qquad (7)$$

and substituting in equation (3) and equating coefficients we get

$$m^2 - n^2 = rg - \omega^2 LC$$

$$2mn = \omega(rC + gL) \qquad (8)$$

But $\omega L = x$, the reactance per unit length, and $\omega C = b$, the capacity susceptance per unit length, therefore these equations may be written

$$m^2 - n^2 = rg - bx$$

$$2mn = br + gx \qquad (9)$$

If we represent the impedance $\sqrt{r^2 + x^2}$ by z and the ad-

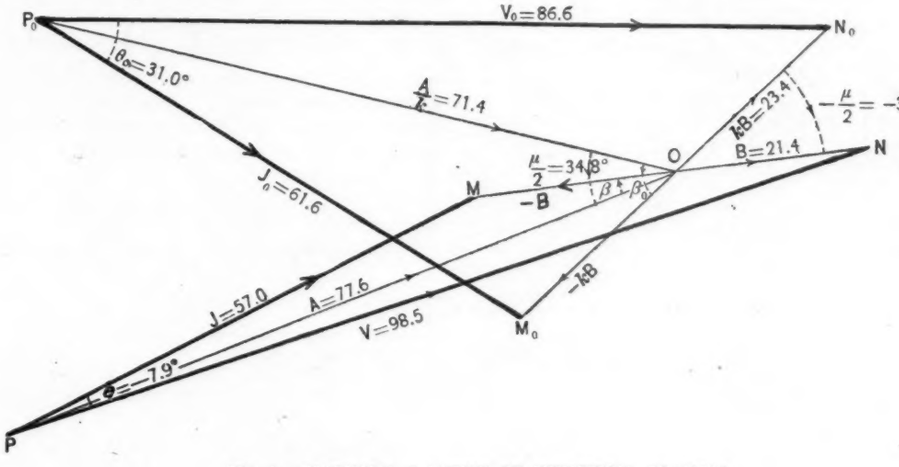


FIG. I.—GRAPHICAL SOLUTION OF NUMERICAL EXAMPLE.

Lay off $P_0N_0 = V_0$ and $P_0M_0 = J_0$, making the angle θ_0 with each other. Then measure the length of the line $ON_0 = OM_0$ and the line P_0O. Calculate k and $\frac{\mu}{2}$ from the formulæ given above. Then lay off $O\,N = C\,M = \frac{ON_0}{K}$, making the angle $\frac{\mu}{2}$ with ON_0 and $PO = kP_0O$, making the angle $\frac{\mu}{2}$ with P_0O. Then $V = PN$, $J = PM$ and $\theta = \angle\, NPM$. Note that in this example J leads V, and therefore θ is to be taken negative.

[1] For either a single-phase (2-wire) or a three-phase (3-wire) system with wires symmetrically arranged $C = 2 \times$ (capacity between any two wires), and $g = 2 \times$ (leakage conductance between any two wires).

mittance $\sqrt{g^2+b^2}$ by y, and the power-factor angles of the impedance and admittance by $\epsilon\left(=\cos^{-1}\frac{r}{z}\right)$ and $\eta\left(=\cos^{-1}\frac{g}{y}\right)$ respectively, we have that

$$r = z\cos\epsilon \qquad g = y\cos\eta$$
$$x = z\sin\epsilon \qquad b = y\sin\eta \qquad (10)$$

which substituted in (9) give

$$m^2 - n^2 = y\,z\,(\cos\eta\cos\epsilon - \sin\eta\sin\epsilon) = y\,z\cos(\eta+\epsilon)$$
$$2\,m\,n = y\,z\,(\sin\eta\cos\epsilon + \cos\eta\sin\epsilon) = y\,z\sin(\eta+\epsilon) \qquad (11)$$

Squaring and adding these two equations, and taking the square root of the sum gives[1]

$$m^2 + n^2 = y\,z \qquad (12)$$

Combining (12) with the first of equations (11) we get

$$m = \pm\sqrt{y\,z}\sqrt{\frac{1+\cos(\eta+\epsilon)}{2}} = \pm\sqrt{y\,z}\cos\left(\frac{\eta+\epsilon}{2}\right)$$

and (13)

$$n = \pm\sqrt{y\,z}\sqrt{\frac{1-\cos(\eta+\epsilon)}{2}} = \pm\sqrt{y\,z}\sin\left(\frac{\eta+\epsilon}{2}\right)$$

Since b and x are always positive under the conditions of the problem in hand, η and ϵ are each positive and less than 90 deg., therefore the angle $(\eta+\epsilon)$ and the expressions $\sqrt{y\,z}\cos\left(\frac{\eta+\epsilon}{2}\right)$ and $\sqrt{y\,z}\sin\left(\frac{\eta+\epsilon}{2}\right)$ are positive quantities, and from the second of equation (11) we also have that the product $m\,n$ must also be positive. Consequently there are two, and only two pairs of values of m and n, which will satisfy the physical conditions of the problem, namely,

$$m = +\sqrt{y\,z}\cos\left(\frac{\eta+\epsilon}{2}\right) \text{ and } n = +\sqrt{y\,z}\sin\left(\frac{\eta+\epsilon}{2}\right)$$

and

$$m = -\sqrt{y\,z}\cos\left(\frac{\eta+\epsilon}{2}\right) \text{ and } n = -\sqrt{y\,z}\sin\left(\frac{\eta+\epsilon}{2}\right) \qquad (13a)$$

Therefore the complete solution of equation (3) for the term having the frequency $\frac{\omega}{2\pi}$ is

$$v = A_0\,e^{ml}\sin(\omega\,t + n\,l + \alpha_0) + B_0\,e^{-ml}\sin(\omega\,t - n\,l + \beta_0) \qquad (14)$$

where m and n are given by equation (13) using the positive sign. The quantities A_0, B_0, α_0 and β_0 are integration constants fixed by the terminal conditions. By properly choosing the time from which t is measured we can put $\alpha_0 = 0$ and equation (14) may be written

$$v = A_0\,e^{ml}\sin(\omega\,t + n\,l) + B_0\,e^{-ml}\sin(\omega\,t - n\,l + \beta_0) \qquad (14a)$$

The physical meaning of this equation is that the pressure along the line is due to two waves of pressure, one advancing along the line in the direction of the receiver with a gradually diminishing amplitude, the other traveling in the opposite direction with the same velocity, but with an increasing amplitude; the second wave may be looked upon as a reflected wave.

The value of the current at any point along the line may now be determined by substituting (14a) in (2) we get

$$\frac{di}{dl} = g\,A_0\,e^{ml}\sin(\omega\,t + n\,l) + g\,B_0\,e^{-ml}\sin(\omega\,t - n\,l + \beta_0)$$
$$+ b\,A_0\,e^{ml}\cos(\omega\,t + n\,l) + b\,B_0\,e^{-ml}\cos(\omega\,t - n\,l + \beta_0)$$

which integrated with respect to l gives[2]

$$i = \sqrt{\frac{y}{z}}\left[A_0\,e^{ml}\sin\left(\omega\,t + n\,l + \frac{\eta-\epsilon}{2}\right) - B_0\,e^{-ml}\sin\left(\omega\,t - n\,l + \beta_0 + \frac{\eta-\epsilon}{2}\right)\right] \qquad (15)$$

which means that the current at any point in the line is the resultant of two waves of current, a direct and a reflected wave, the amplitudes of which are proportional to the amplitudes of the corresponding pressure waves, the direct current-wave leading the pressure-wave by the angle $\frac{\eta-\epsilon}{2}$ and the reflected current-wave leading the reflected pressure-wave by the angle $\pi + \frac{\eta-\epsilon}{2}$.

Or, interpreting equations (14a) and (15) in terms of vectors, we have that the pressure at the receiver ($l=0$) is the sum of two vectors A_0 and B_0 making the angle β_0 with each other, and that the current at the receiver is equal to the difference of these same two vectors multiplied by $\sqrt{\frac{y}{z}}$ and turned through an angle $\left(\frac{\eta-\epsilon}{2}\right)$. As we go along the line toward the generating end the vector A increases in length to $A_0\,e^{ml}$ and rotates in the positive direction through an angle $(n\,l)$, while the vector B decreases in length to $B_0\,e^{-ml}$ and rotates in the opposite direction through an equal angle $(-n\,l)$; the pressure at any point is therefore the sum of the two vectors $A\,(=A_0\,e^{ml})$ and $B\,(=B_0\,e^{-ml})$ making an angle $(\beta_0 - 2\,n\,l)$ with each other, and the current is equal to the difference of the same two vectors multiplied by $\sqrt{\frac{y}{z}}$ and turned through an angle $\left(\frac{\eta-\epsilon}{2}\right)$. If we let

V = vector representing pressure at any point on the line
I = vector representing current at this point
A = vector representing $A_0\,e^{ml}\sin(\omega\,t + n\,l)$ at this point
B = vector representing $B_0\,e^{-ml}\sin(\omega\,t - n\,l + \beta_0)$ at this point
J = vector representing $I\sqrt{\frac{z}{y}}$ turned through the angle $\left(\frac{\eta-\epsilon}{2}\right)$
ϕ = angle that I lags behind V, i.e., the power-factor angle
$\Theta = \phi + \frac{\eta-\epsilon}{2}$ = angle by which J lags behind V,

we then have diagrammatically Figs. 2 and 3.

Fig. 2 enables us to determine immediately the constants A_0, B_0 and β_0 in terms of the pressure, current and power factor at the receiver. This may be done graphically as indicated by the figure or algebraically from the following formulas

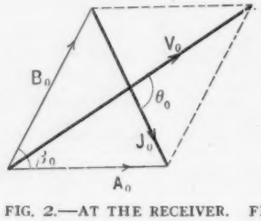


FIG. 2.—AT THE RECEIVER.

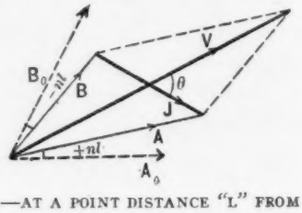


FIG. 3.—AT A POINT DISTANCE "L" FROM RECEIVER.

$$4\,A_0^2 = V_0^2 + J_0^2 + 2\,V_0 J_0\cos\Theta_0$$
$$4\,B_0^2 = V_0^2 + J_0^2 - 2\,V_0 J_0\cos\Theta_0$$
$$\cos\beta_0 = \frac{V_0^2 - J_0^2}{4A_0\,B_0} \qquad (16)$$

The pressure, current and power-factor angle at a point a distance l from the receiver can then be determined from the following formulas, which are derived immediately from Fig. 3.

$$V^2 = A^2 + B^2 + 2\,A\,B\cos(\beta_0 - 2\,n\,l)$$
$$J^2 = A^2 + B^2 - 2\,A\,B\cos(\beta_0 - 2\,n\,l)$$
$$\cos\Theta = \frac{A^2 - B^2}{V\,J} \qquad (17)$$

where

$$A = A_0\,e^{ml} \text{ and } B = B_0\,e^{-ml}$$

For numerical calculations these formulas can be put in the more convenient shape given at the beginning of this discussion.

If harmonics are present in the pressure impressed on the line, there will be a similar set of equations for each frequency that may be present.

[1] Mathematically we also get $m^2 + n^2 = -\,y\,z$, but since m and n are both real quantities and y and z represent two positive physical quantities, this relation is inconsistent with the physical conditions of the problem.

[2] Note that $\int e^{ml}\sin nl = \frac{me^{ml}\sin nl - ne^{ml}\cos nl}{m^2+n^2}$

and that $\int e^{ml}\cos nl = \frac{me^{ml}\cos nl + ne^{ml}\sin nl}{m^2+n^2}$

whence, making use of the relations (12) and (13) and the definition of the angle η, we get equation (15).

Special Motor-Controlling Devices in the Rolling Mill of the Indiana Steel Company, Gary, Ind.

OUR issues for May 13 and 20, 1909, contained articles by Mr. E. A. Lof describing the switchboard equipment and the distributing circuits installed in the Gary plant of the Indiana Steel Company, the generators for which were described in our issue for Sept. 26, 1908, and the motor equipment, March 18, 1909. When it is recalled that although the mill is driven exclusively by electric motors and 100,000 tons of rails are turned out per month, yet only eight motor operators are required, it will be appreciated that the problems connected with the control of the motors have been well solved. In the present article will be given an outline of the motor-controlling devices employed in operating the rolling mill.

As noted in previous issues, two 2000-hp induction motors of the constant-speed type serve for driving the four sets of rolls for the 40-in., two-high blooming mills. These motors cover four of the 18 "passes" intervening between the "soaking pit" and the "hot bed," or from the heated stock in the rough to the finished rail.

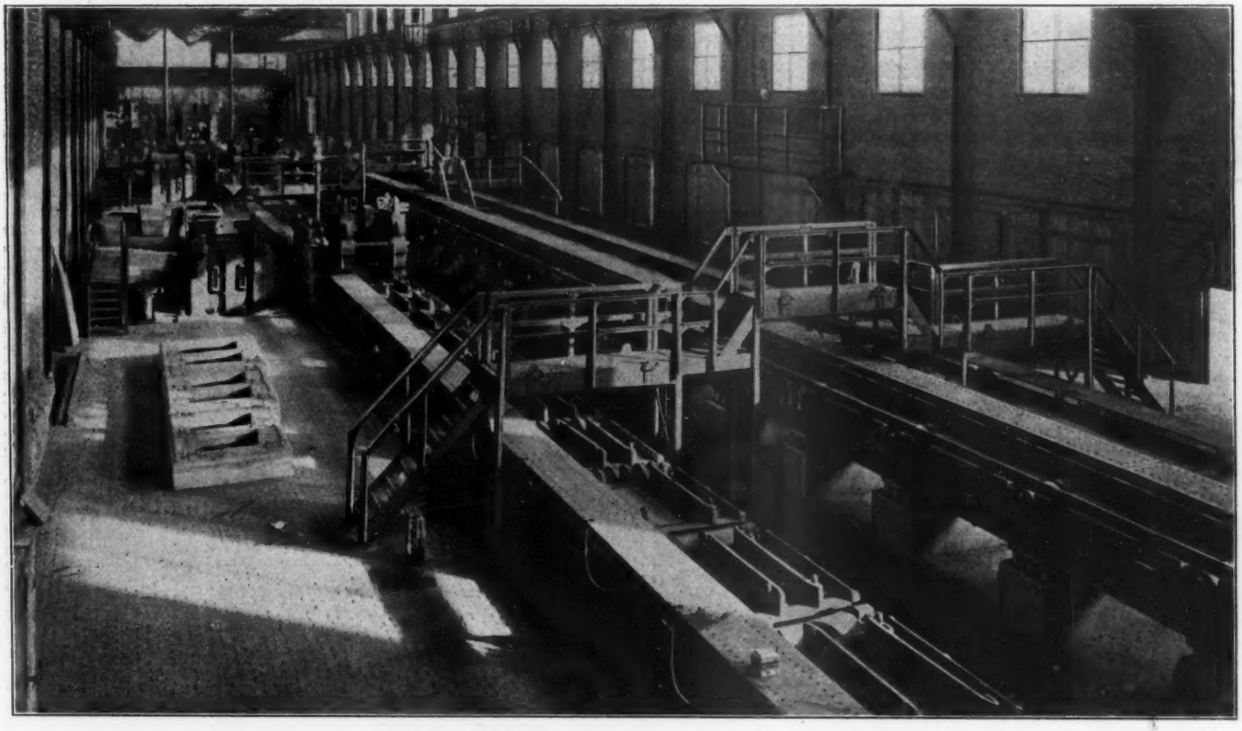


FIG. I.—GENERAL VIEW OF RAIL MILL.

Two 6000-hp induction motors operate passes Nos. 5, 6, 7, 8, 9, 10, 11, 12, 16 and 17, while one 2000-hp and one 6000-hp induction motors operate the remaining passes, Nos. 13, 14, 15 and 18. Each pass represents the movement of the heated steel between rolls and results in a decrease in cross-section with increase in length of the mass. The rolls, during normal operation, are driven at approximately constant speed so that the controlling apparatus for the induction motors could be of the simple type suitable merely for bringing the machines to full speed from complete rest at the proper rate. However, the load on these motors is of a violently fluctuating nature and means are employed for reducing the fluctuations in their demand for power from the supply system. In addition to the large flywheels with which one of the machines is provided, each motor is equipped with automatic devices for increasing the secondary resistance with increase of load on the machine and decreasing the resistance when the load is removed.

Between each pass the stock is turned through 90 deg., while at the three-high blooming mill it must be elevated and lowered, according to the direction in which it is to travel. Moreover, the stock must be shifted in horizontal position at two points. For accomplishing these results there are provided 21 tables and two transfers. Each table is equipped with small rolls, for causing the stock to move in the desired direction, the rolls being driven by motors of the mill type resembling steel-car motors. Each of these motors is equipped with an automatic current-limiting controller. The controller is of the contactor type, the arrangement being such that as the starting resistance is decreased step-by-step the current is kept within definite limits. When the operator closes the switch all of the resistance is in circuit. The first section can be short-circuited only when the current has decreased to the value for which the controller is adjusted; similarly the second, third, fourth, etc., sections. The contactors are closed by electromagnets whose coils are inoperative when the current exceeds the permissible value. The transfers are operated by motors of the mill type equipped with current-limiting controllers similar to those just described. The act of moving the stock horizontally on the transfer is accomplished by means of motor-driven chains, the controller being so adjusted that when the operator places the handle in the forward position the chain moves the rail to the proper place and automatically comes to rest.

Probably the most interesting electrical feature of the installation is the equipment provided for operating the lifting table used in connection with the three-high blooming mill. The table, which weighs about 250,000 lb., is lifted or lowered as required through a distance of 43 in. in the remarkably short time of three seconds. This task is performed by a 250-hp motor designed for a normal speed of 100 r.p.m. Even if the motor were to run at full speed throughout the whole of the three seconds, it would complete only five revolutions. Considering the time consumed in accelerating and in coming to rest, it will be seen that the motor actually does its whole work of lifting the table while making less than four complete revolutions. The table is supported on huge bell cranks, which are connected to a rotating crank driven by the motors. By means of automatic controlling devices the throwing of a master lever starts the table

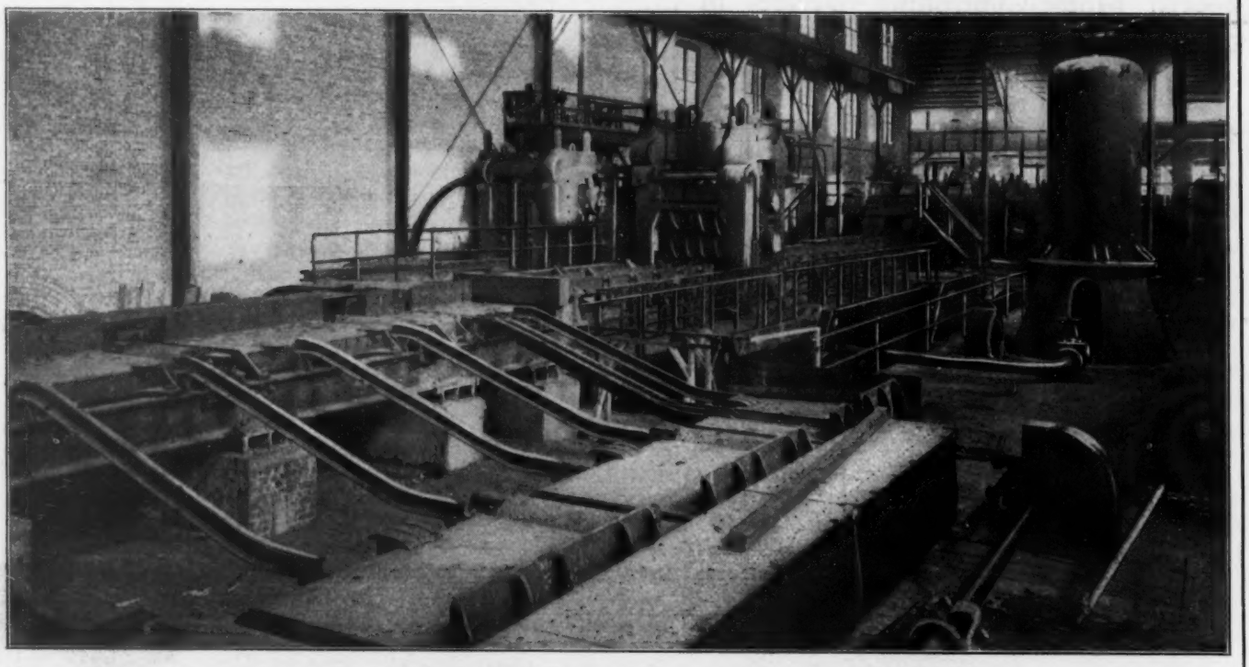


FIG. 2.—43-IN., THREE-HIGH BLOOMING MILL, WITH MOTOR-OPERATED ELEVATING TABLE.

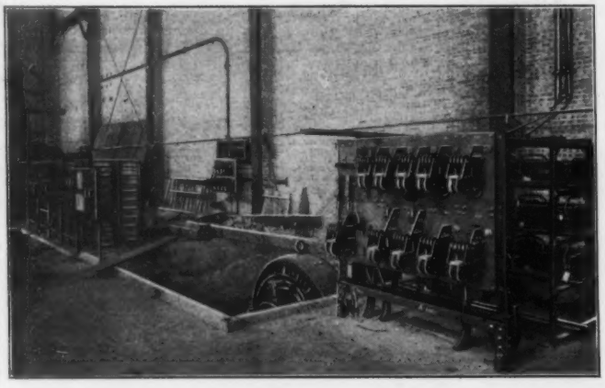


FIG. 3.—CONTROLLER FOR 250-HP DIRECT-CURRENT MOTOR USED TO RAISE AND LOWER BLOOMING-MILL TABLE.

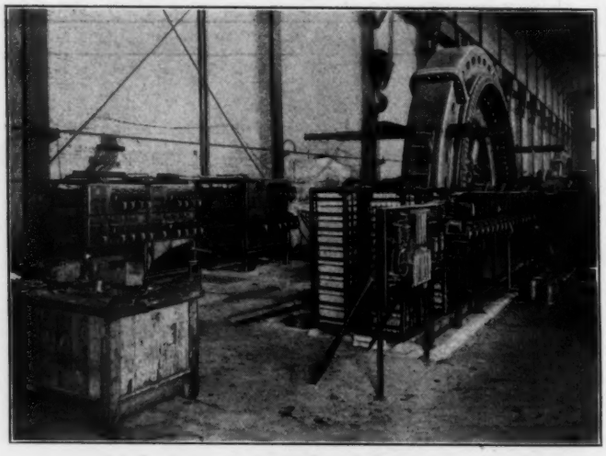


FIG. 5.—6000-HP MOTOR AND CONTROLLER.

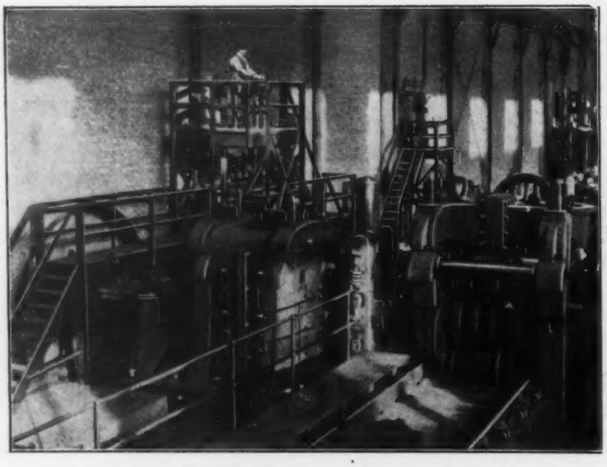


FIG. 4.—OPERATING PULPIT, THREE-HIGH ROUGHING MILL.

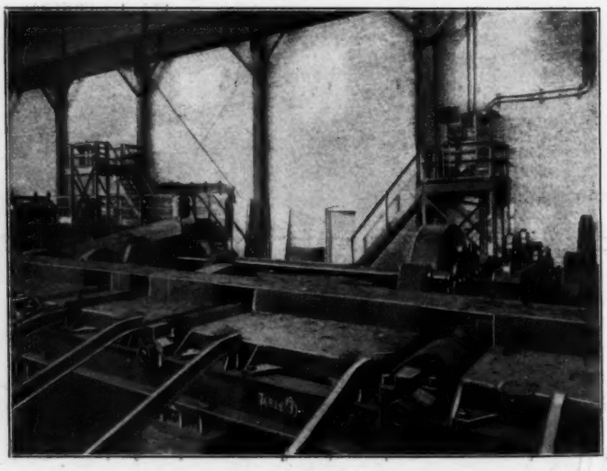


FIG. 6.—LOOKING ACROSS RAIL TRANSFERS AND BLOOM SHEAR TABLES.

SPECIAL MOTOR-CONTROLLING DEVICES IN THE ROLLING MILL OF THE INDIANA STEEL COMPANY, GARY, IND.

from the low-level position and raises it to the highest level, where it is automatically stopped. In lifting the table from the low to the high level, the rotating crank revolves through an arc of 180 deg. in the same direction, thereby bringing the table to the low level once more. The operation of raising or lowering the table, which is accomplished in a period of three seconds, is quite remarkable when the masses to be accelerated, slowed

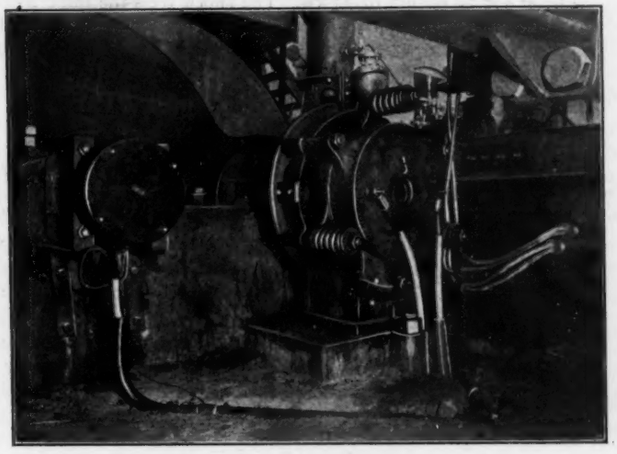


FIG. 7.—VIEW UNDERNEATH TILTING TABLE AT THREE-HIGH RAIL ROUGHING MILL.

down and stopped are considered. A portion of the weight of the table is counterbalanced hydraulically and pneumatically. The bell cranks carrying the table are connected to hydraulic cylinders piped to a compression tank partially filled with air at 500 lb. pressure. When the table is down the air pressure in the compression tank overcounterweights the table by 25 per

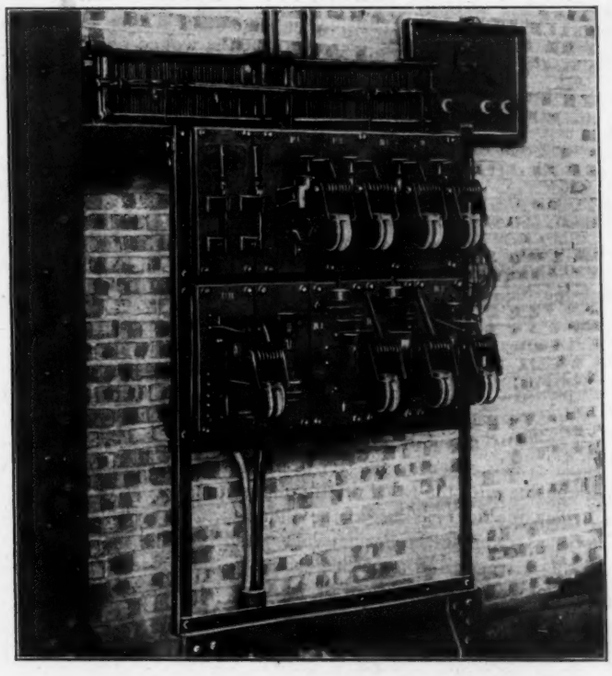


FIG. 8.—TYPICAL CONTACTOR CONTROLLER INSTALLATION.

cent. When the table is up it is undercounterweighted by 25 per cent. This result is accomplished by a proper proportion of the air and water in the system. Observations have shown that the motor reaches almost full speed before the table begins to change its speed appreciably, so that the motor requires little more than full-load current at any one time in spite of the trying conditions under which it operates. A solenoid brake is provided for bringing the motor to rest at the exact point required.

One of the tilting tables used with the three-high roughing mill is pivoted and the other end is supported on a bell crank driven by a 150-hp direct-current motor, by which it is moved 26 in. either up or down in 1.5 seconds. The controller for this motor is similar to that for the lifting-table motor.

Between passes Nos. 9 and 10 the stock, which has been reduced from a sectional area of 375 sq. in. to 59 sq. in. and increased in length from 6.7 ft. to 43 ft., is cut into two unequal lengths by means of bloom shears driven by a 75-hp induction motor, while the pin on the clutch is driven by a direct-current 5-hp auxiliary motor. The circuit of the latter motor is interlocked with the controlling device for the alternating-current motor so that the former cannot be operated except when the latter is running at full speed. The latch is operated by a crank to which the smaller motor is geared. Pressure on a push button under control of the operator causes the motor to run long enough to revolve the crank through 360 deg., thereby releasing the clutch and returning the pin to the initial or "off" position.

The ingots from which the rails are rolled are taken from soaking pits, in which they are reheated after leaving the open-hearth furnaces. There are 12 soaking pits in all, six on either side of the rail mill. Two electrically operated ingot buggies

FIG. 9.—THREE OF THE FIVE HOT SAWS FOR SAWING RAILS.

deliver the heated ingots to the rail mill, each buggy serving six pits. For the operation of these ingot buggies there has been developed an ingenious arrangement of controlling devices. On account of the length of the building in which the soaking pits are located, it is impossible for the operator stationed at the mill to see when an ingot buggy is opposite a particular pit. It was deemed necessary to guard against the possibility of the operator becoming confused and bringing both ingot buggies to the mill at the same time, which would result, of course, in a collision. The special automatic controlling system provided guards against this contingency, while at the same time it enables the operator to stop the ingot buggy at any of the pits by merely setting a controlling lever on the notch corresponding to the pit in front of which it is desired to halt the buggy. The operator in the mill has in front of him two master levers for the control of the two buggies. Each of these controlling levers can be set in any of eight positions, one of these positions corresponding to the mill itself, six to the six soaking pits, which the buggy serves, and one off position. If, when one of the ingot buggies is at the mill, the operator desires it to go to pit No. 5, for example, and there stop, he merely moves the controlling lever to the position corresponding to pit No. 5 and the buggy proceeds to that point and is there automatically stopped. A suitable interlock which is provided between the two controlling levers renders it impossible for the operator to throw both levers to the mill position at the same time, thus insuring a clear track for each buggy.

The current-limiting controller and the special controlling devices used with the direct-current motors described above were designed and built by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis.

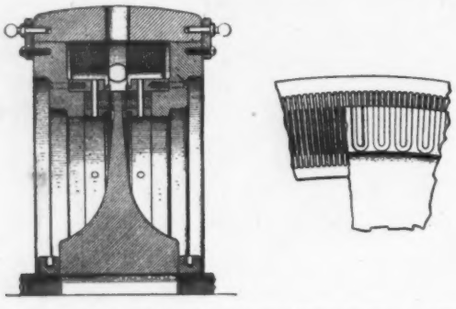
Abstracts of A. I. E. E. Convention Papers and Discussions

FOLLOWING are abstracts of the papers presented last week at the Frontenac convention of the American Institute of Electrical Engineers, together with abstracts of the discussions to which they gave rise. The arrangement is not in order of presentation, but in groups according to general subject. Elsewhere is given an account in detail of the proceedings of the convention, including its social features.

Electrical Design and Testing.

ALTERNATORS FOR WIRELESS SERVICE.

An alternator rated at 2 kw and 100,000 cycles per second, intended for wireless service, was described in a paper by Mr. E. F. W. Alexanderson, of the General Electric Company. In building such a machine difficulties are encountered on account of the large losses and by reason of the high speed required. The constructive details of the machine are shown in Figs. 1 and 2. The armature has 600 slots with one conductor per slot of 0.013-in. copper wire triple-silk covered and varnished. The wire is wound in a continuous wave up and down in the successive slots, as indicated in Fig. 2. The rotating field core has 300 projections which, as the machine is of the inductor type, correspond to 600 poles. The air-gap, which is adjustable, is set at about 0.015 in. The shaft is of the flexible type, designed



FIGS. 1 AND 2.—ALEXANDERSON HIGH-FREQUENCY ALTERNATOR.

like a stiff spring with uniform strength, 1.25 in. in diameter at the middle, and 0.625 in. in diameter at the ends, the length between the center of the bearings being 28 in. In order to minimize air friction the 300 slots between the revolving field slots are filled with non-magnetic material. The peripheral speed is 1000 ft. per second. The alternator has a no-load e.m.f. of 110 volts, and when used in conjunction with a suitable condenser in series delivers 30 amp at 70 volts or 2.1 kw at full load. Regarding the possibilities of building high-frequency alternators of higher output, the author mentioned that a machine for 50,000 cycles is being designed for an output of 35 kw.

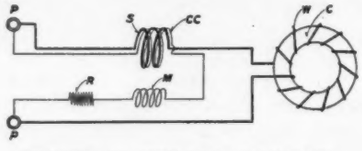
Discussion.

Mr. D. B. Rushmore, Schenectady, pointed out the tendency toward the use of velocities limited only by the strength of the materials. Dr. Kennelly, Harvard University, emphasized the more interesting features of the paper, and in reply to questions by Messrs. J. B. Taylor, Schenectady; J. C. Lincoln, Cleveland, and C. J. Fechheimer, Milwaukee, Mr. Alexanderson said that in this machine the falling off in voltage with increasing field excitation is due to the saturation of the whole space between the armature and the rotary member, as in the ordinary inductor alternator. The useful output of the alternator can be increased by placing a condenser in series with the armature. In the machine described a diameter of 1 ft. was taken as an even dimension, and the cost of manufacture was less with a small machine. A high-frequency machine is now being built 36 in. in diameter for an output of 35 kw. The shock feels the same with the small machine as a direct-current shock. The mechanical resonance of the shaft has nothing to do with the critical speed. The bearings are self-aligning.

CORE-LOSS VOLTMETER.

The accompanying diagram relates to the circuits of a core-loss voltmeter discussed in a paper by Mr. L. W. Chubb, of the Westinghouse Electric & Manufacturing Company. The voltmeter consists essentially of a ring or core of laminated steel excited by a winding, and a wattmeter of suitable design on which to read the power input to the ring and all copper circuits in the instrument. The core and meter are mounted in a wooden case.

On the laminated core *C* is placed a winding *W*, the core member and winding being securely mounted in the lower case, and the two leads of the winding brought through the top and



CIRCUITS OF IRON-LOSS VOLTMETER.

into the instrument case, which contains the meter movement. A stationary current coil *S* is connected in series with the winding *W* and the terminals *PP*. The shunt circuit consists of the moving coil *M*, the non-inductive resistance *R*, and the compensating or adding coil *CC*, which is wound parallel to the series coil and of an equal number of turns.

Before calibrating the instrument for a certain frequency, the adjustment of the ratio of eddy loss in the ring plus shunt copper loss, to the total loss, is made by changing the non-inductive resistance in the shunt circuit and the turns on the ring. This ratio of I^2R losses to total loss is made to be 20 per cent at about six-tenths of full-scale voltage. After this adjustment is made, the instrument is calibrated in parallel with an alternating-current voltmeter on the pure sine-voltage wave of the required frequency from a small smooth-core alternator. The scale is drawn in to agree with the alternating-current instrument.

The iron-loss voltmeter may be used as a portable voltmeter in testing transformer core losses on any reasonably distorted wave of voltage. The test may be conducted without any knowledge of the wave-form. The voltage may be regulated through a considerable range by the aid of resistance or inductance, thus dispensing with the usual multi-voltage transformer or means of varying the field current of the alternator. The frequency need only approximate the normal value; and the final result of core loss as measured on a wattmeter will be the value which would be obtained on a sine wave of voltage at the normal frequency and voltage of the transformer.

The instrument possesses the disadvantage of being heavier than the ordinary alternating-current voltmeter. The internal losses of the instrument are high and in testing very small transformers the correction for instrument losses is as large as the core loss of the transformer. For high-voltage tests the usual voltage transformer cannot be used on account of the relatively large current taken by the instrument and its poor power factor. A voltage transformer to be used with the iron-loss voltmeter must be specially designed with heavier copper and low reactance. The instrument can be made direct reading for only one frequency, and, when used on other frequencies, must be used with a calibration curve. The author claimed that

these disadvantages are not of great importance, as there are generally low-voltage taps on high-voltage transformers, to which the meter can be connected, and there are only a few standard frequencies in terms of which tests will be required.

Discussion.

Prof. Frederick Bedell, Cornell University, stated that if the instrument can be depended upon it will be very valuable. Dr. C. P. Steinmetz said that the definition of "form factor" in the paper is unfortunate. The correct definition is the ratio of the effective divided by the mean in the actual wave to the effective divided by the mean in the sine wave. Dr. M. G. Lloyd, Washington, D. C., suggested that the difficulties of getting a true sine wave might limit the value of the instrument in engineering service. The readings are accurate when eddy current losses bear a definite proportion to the hysteresis losses. Different varieties of steel might limit the use of the instrument. Its excessive weight hardly allows it to be classed as portable. Mr. L. T. Robinson, Schenectady, said that, in his opinion, the instrument is limited in its application to a line of transformers built by certain designers. Professor Bedell spoke of the German definition of "form factor" as the ratio of the mean to the effective value of the wave, giving 0.9 for the sine wave and 1.00 for the square-topped wave. Mr. C. F. Scott called attention to the instrument as essentially a practical device. It enables the use of many other instruments to be avoided, and obviates the use of elaborate, extensive and cumbersome measurements. It has proved of great value in the factory. Dr. Steinmetz described a method of obtaining a sine wave from a circuit containing inductance, resistance and capacity. He said that the instrument is useful and interesting, but that it is generally desirable to take only a small amount of power in testing transformers. Mr. Chubb in closing said that the instrument has now been in service practically 2½ years. It is very useful in testing large transformers, which could not be satisfactorily run from small generators. It has no air-gap and is built of non-aging material. It develops an error of perhaps 0.1 per cent in a month. It can be used on transformers built of either open-hearth or silicon steel, and is in all cases more accurate than the root-mean-square instrument.

THE TESTING OF TRANSFORMER STEEL.

A paper by Messrs. M. G. Lloyd and J. V. S. Fisher, of the Bureau of Standards, discussed the conditions which should be realized in the measurement of energy losses in sheet iron and steel subjected to alternating magnetization, with a description of a modification of the Epstein method, which has been adopted as standard in Germany. This method is believed to better satisfy the desired conditions and to give an accuracy of 1 per cent with the use of less than 2 kg (4.4 lb.) of material. Results were given showing a wide range in the quality of material in general use, quality having slight connection with price. Several foreign specimens of ordinary steel and silicon steel were included for comparison with the American product. Silicon steel contains from 3 to 4 per cent silicon, the quality not depending upon the exact percentage of silicon.

By making measurements at two frequencies, the eddy current and hysteresis losses were separated and a study was made of the variation of each with flux density. The values of the hysteretic constant and the total loss in watts per pound at 60 cycles and 10,000 gausses were tabulated.

The effects of artificial aging are shown to depend upon the flux density selected for test, the hysteresis increasing more for 5000 than for 10,000 gausses. The authors stated that tests should, therefore, be made at the density to be used. They found that the aging is usually negligible in silicon steels.

Discussion.

Mr. L. T. Robinson, Schenectady, spoke of the value of the Epstein and other long-established methods of testing iron and steel samples, and said that in the General Electric factory the cost of each test per sample has been cut to 5 cents. Professor Karapetoff, of Cornell University, touched upon the disadvantages of using separate corner pieces, in the Lloyd tests, giving two joints instead of one, as in the Epstein method. A written communication was presented from Mr. C. E. Skinner, Pittsburgh, complimenting the work of Dr. Lloyd, with a few slight differences of opinion. Mr. Andrew Pinkerton, Pittsburgh, suggested that the time required to build up test sheets is an objection to the methods described, and Prof. E. E. F. Creighton, Schenectady, touched upon the great difference in magnetic material resulting from the methods of cutting up sheets and the furnace treatment.

In closing the discussion, Dr. Lloyd said that the Epstein method is not as accurate or satisfactory for separating the eddy current and hysteresis losses. He could see no harm in developing any number of good testing methods. One cannot expect any alternating-current method to give the results of the ballistic method. The latter is not a criterion of the accuracy of the alternating-current measurements. The methods described in the paper give an accuracy of 1 per cent. Ordinarily the same material as the test pieces are used in the joints at the corners. He considers it best not to anneal test pieces after receiving them. The usual tests require a 22-lb. piece, but here a 4-lb. sample is sufficient. It is undesirable to let the exciting current run too high. The magnetizing current of silicon steel has nothing to do with the regulation and a high magnetizing current is not objectionable on that ground.

REPULSION MOTOR WITH VARIABLE-SPEED SHUNT CHARACTERISTICS.

Mr. E. F. W. Alexanderson, of the General Electric Company presented a paper dealing with a so-called "repulsion motor with variable-speed shunt characteristics." This machine is a commutator type of alternating-current motor provided with two pairs of brushes in magnetic quadrature. One pair of brushes is placed in line with the main primary magnetism and carries the power current, while the other pair carries the exciting current. The no-load speed of the machine is synchronism when the brush pairs are short-circuited; when a voltage from the outside is introduced into either the circuit of the main brushes or the circuit of the exciting brushes, a corresponding change is made in the no-load speed. The impressed e.m.f. can be either positive or negative, and consequently the speed can be regulated below synchronism as well as above synchronism. This type of motor is being developed for doing the work of the adjustable-speed, shunt-connected, direct-current motor where only alternating current is available.

This paper was discussed in connection with Mr. Creedy's paper, which follows:

ADJUSTABLE-SPEED SINGLE-PHASE COMMUTATOR MOTOR.

A paper by Mr. F. Creedy, of the Westinghouse Electric & Manufacturing Company, gave a sketch of the theory of the adjustable-speed, single-phase, "shunt induction motor," which is a single-phase commutator motor possessing speed characteristics similar to those of a shunt-connected, direct-current motor. The machine is provided with two pairs of brushes, one in line with the main primary field flux and the other in magnetic quadrature therewith. In series with the latter pair of brushes there is connected either an inductive or a condensive circuit, the former raises the speed, while the latter lowers it. The author expressed the opinion that the use of inductance in conjunction with a small adjustable compensating transformer offers a very promising means of varying the speed. However, the efficiency is low on account of the large commutator losses.

Discussion.

Professor Karapetoff questioned the terminology of Mr. Creedy's paper. Mr. Alexanderson said that Mr. Creedy had presented an excellent review of the work of that type of motor. The system of compensating for power factor as developed by Milch is fundamental. Good methods of speed regulation are now reasonably available. With armature control a speed variation of 3 to 1 can be obtained, and with field control a range of 1.5 to 1. There is simpler control with the single-phase shunt motor than with the three-phase machines. Mr. Creedy, in closing, considered various wiring schemes and reviewed the more important points of Mr. Alexanderson's paper, specially noting the speed variation secured below synchronism. He ap-

plies the general term "induction motor" to any motor having current "induced" in the rotating member.

THE HEATING OF INDUCTION MOTORS.

The limitations imposed on the designer of induction motors by the heating of the machine, and methods for predetermining the heating were outlined in a paper by Mr. A. Miller Gray, of the Allis-Chalmers Company. He called attention to the fact that the stirring up of the air within the machine is of equally as much importance in an enclosed motor as it is in one of the open type.

There was no discussion on this paper.

THE CURRENT LOCUS OF THE SINGLE-PHASE INDUCTION MOTOR.

Prof. A. S. Langsdorf, of Washington University, presented a paper giving a mathematical demonstration tending to show that the equivalent electric circuits of the single-phase induction motor contains a variable admittance component as well as a variable conductance component in parallel, but that the current locus for constant impressed e.m.f. is a time-circle. The demonstration is somewhat similar to that given by Mr. K. J. Laurell in our issue for July 11, 1908, but differs therefrom in that the shunted admittance of the speed field is assumed to vary inversely with the square of the speed. The author's conclusions differ from those of Mr. Laurell with reference only to the center of the circular current locus.

Discussion.

Professor Karapetoff urged the need of considering the subject from a simpler point of view, so far as teaching it is concerned. Professor Langsdorf discarded Ferrari's assumption of two fields revolving in opposite directions, in the former's effort to come down to physical conditions. From the pedagogical standpoint the conception of the squirrel-cage motor as a revolving transformer is desirable. The reaction is not the same from point to point in the squirrel-cage and phase-wound machines. The expression given for the impedance of the motor is complex on account of the reciprocals used. Presumably admittances could be substituted to simplify it. Professor Langsdorf, in closing, adhered to the equations presented in the paper as the simplest available.

MULTISPEED INDUCTION MOTOR.

A paper by Messrs. H. G. Reist and H. Maxwell, of the General Electric Company, which was read by the former, outlined the characteristics of induction motors arranged for multispeed service. They discussed three methods for varying the effective number of poles, namely, regrouping a single set of coils, using two sets of coils, and concatenation. Referring to these types as *a*, *b* and *c*, respectively, the authors made the following suggestions:

1. For two speeds having a ratio of 2:1, use motor type (*a*).
2. For two speeds having other ratios than 2:1, use motor type (*b*), except when the winding and insulation require too much space.
3. When three speeds are required, two having a ratio of 2:1, the other being intermediate, type (*b*) may be used with one winding connected as in (*a*).
4. If four speeds are necessary, one speed being one-half of the highest speed, and the lowest speed one-half of the next highest speed, type (*b*) may be used, with each winding such as is used in type (*a*).
5. Use type (*c*) concatenated motors, when two or more speeds close together are required.
6. Use concatenated motors when polar windings on the rotor are necessary with more than two speeds, or if the two speeds differ from 2:1.
7. Use concatenated motors for high-voltage machines except when type (*a*) can be used.

Discussion.

Mr. H. C. Specht, Pittsburgh, pointed out that for the various schemes of connections the number of leads is generally dependent upon the number of poles and the type of winding. The maximum output is dependent on the limited density in the copper and iron, and the stresses in the mechanical parts. If the synchronous speed of the second motor is higher than that of the differential concatenation, then the second motor may be connected to the line instead of to the first motor. In the case where neither one of the two motors has a lower synchronous speed than that of the differential concatenation, the speed for the latter cannot be obtained without auxiliary means. Mechanical interconnection has its field where different speeds are required. By a cascade set practically any possible combination of speeds can be obtained, but this cannot be done by multi-speed single motor equipment. The individual motors of a cascade set can be designed for greater width and smaller diameter, thus keeping the peripheral speed lower than would be the case for a single motor for the same speeds. Mr. A. M. Dudley, Swissvale, Pa., suggested that another method of getting multi-speed service is by internal concatenation, putting a two-speed winding on the stator member and also on the rotor. The idle primary is short-circuited and the speed depends upon the number of poles.

Dr. C. P. Steinmetz said that there is not much, if any, gain in concatenation or cascade connection compared with changing the poles. The difficulty is to avoid too many poles and hence too large a motor. If one doubles the number of poles to get half the speed, the motor constant is thereby made inferior. In any case the motor has to be designed better than for high speeds. In concatenation each motor always keeps the same number of poles. One motor only reacts on the supply circuit, and it carries the exciting current of the other motor. The electrical constants of a concatenated couple are inferior, and the characteristics are the same as those of a motor which changes its number of poles. The latter is superior mechanically and from the point of view of manufacturing. Concatenation may be used in railway service. The reactance of the second motor upon the first cannot be overlooked, however.

CORONA PHENOMENA.

In a paper by Messrs. W. S. Moody and G. Faccioli, of the General Electric Company, much interesting information was given concerning certain unexpected results obtained while investigating corona phenomena in air and oil. When between a conducting rod and metallic disk there was impressed an e.m.f. of sinusoidal time-wave shape corona appeared at 57,000 volts; when a conducting cylinder was placed around the center of the rod the corona appeared at 62,300 volts, but when insulating type was wrapped on the center of the rod the corona was formed at a lower e.m.f. A certain rod, ¼ in. in diameter, which glowed at 57,000 volts when its length was 45 in., required 83,500 volts to form a glow when its length was decreased to 12.0 in., the distance to the metallic plate remaining constant at 12.0 in. In all of the experiments reported the shape of the "ends" of the rods had no effect upon the character of the phenomena. In fact, similar results were obtained whether the rod-ends were spheres of large or small diameters or mere ends of cylinders. Moreover, the distances between the rods and the metallic plates, as well as the size of the plates, affected only the voltage to produce corona, and not the general character of the phenomena. The authors concluded from their experiments that the voltage at which corona appears in apparatus not only depends upon the dimensions of the apparatus itself, but is also a complex function of several qualities and conditions. In discussing the effect of oil, they express the opinion that oil does not eliminate corona. For example, when two needles 12 in. apart were submerged in oil no glow is noticeable when the e.m.f. is raised to 100,000 volts, but at 101,000 volts the glowing is very perceptible in the shape of a small, steady brush, noiseless and green in color. When the needles were separated by only 6 in. the glow was established at 78,000 volts, while for 3-in. separation the required e.m.f. was 72,000 volts. The above-mentioned phenomena are of predominating importance in the design of transformers for very high voltages.

Discussion.

Dr. J. B. Whitehead, Johns Hopkins University, spoke of the difficulties of making calculated and experimental breakdown

voltages agree. They sometimes differ 50 per cent. Laboratory investigations are now being made in regard to the potential gradient necessary to start discharge. Prof. J. J. Thomson's theory of spark discharges requires about 500,000 volts per cm for a discharge in air; by Hobbs' corpuscular theory 800,000 volts per cm are required. Ionization by collision takes place at lower values than are required to start and maintain a brush discharge, say 30,000 volts per cm. Mr. J. C. Lincoln, Cleveland, asked if any measure was made of energy dissipated from the wire at the point just below where the corona appeared. Mr. R. D. Mershon, New York, spoke of the relation between the critical point and the point where the discharge begins to take place. Apparently there has to be a considerable loss before there is any noticeable manifestation. The critical point is probably affected by the moisture in the air. Prof. E. B. Charters, Jr., of Stanford University, spoke of tests by Professor Ryan and himself which agree with those of Mr. Moody. A No. 34 wire inside a 4-in. cylinder produced tremendous vibration in oil under the static strain. Mr. Moody, in closing, said that no power measurements were attempted, in view of the small quantities available.

DESIGNING HEAVY-DUTY FUSES.

The relative merits of single-link and multiple-link fuses of the enclosed type were discussed at length in a paper by Mr. Louis W. Downes, of the D. & W. Fuse Company. Tests were reported to show that single-link fuses for heavy duty are unsatisfactory and dangerous, while multiple-link fuses are quiet and satisfactory. These results were attributed to the more intimate relation between the vaporized metal and the cooling filler of the multiple-link as compared with the single-link fuse.

Discussion.

Mr. C. Francis Harding drew attention to the lack of comparisons between the two methods and suggested there should also be some data to show how much heat is dissipated from the soldered joints, what effect the length has and also what effect arises due to the difference between single and multiple arrangement. He considered the statement made as to moisture content misleading, as this would undoubtedly vary with weather conditions. Mr. W. S. Andrews gave a short historical review of fuse history. In 1879 he made the first fusible links for Edison lamp circuits. Early patents show a very crude form of copper-wire ends with soft-lead wire connected between, and troubles were frequently due to bad mechanical construction. Mr. Downes said there is no difference in construction between single and multiple fuses, the only difference being in the support of the fusible link. The object of the filling in an enclosed fuse is to act as a condenser for cooling for the hot gases in order to reduce the vapors from conductors at high temperature to non-conductors at low temperature. Moisture is hard to drive off during operation. Every manufacturer uses practically the same material, namely, the different salts of calcium, such as calcium carbonate. In the original material there is something like 18 per cent of moisture, but by heating this to 600 deg. to 700 deg. it will be reduced to about 5 per cent, above which practice shows no appreciable increase. In answer to a question why tests are made on short-circuit, he stated that manufacturers have been troubled by explosions of the enclosed fuse, and, therefore, feel that the short-circuit test is necessary to realize the worst conditions of operation. It is not difficult to obtain an accuracy within 10 per cent of the rating. The thermal conductivity of the material used for filling decreases rapidly after the temperature rises; several methods are employed to overcome this, such as notching and air-drums—that is, retaining a small air space at the central portion of the link.

COST OF ALTERNATORS.

Mr. Carl J. Fechheimer, of the Allis-Chalmers Company, presented a paper dealing with the comparative costs of 25-cycle and 60-cycle alternators. The author determined the value of flux to render the cost of the alternator of each rating with its exciter a minimum, and used this value of flux for determining the cost of the exciter, the approximate diameter and length of machine, and the weights and costs of material in each of the principal parts of the alternator. Costs were determined for alternators to be driven at 300 and at 100 r.p.m., the former being turbine-type and the latter engine-type machines. The results indicate that a 25-cycle machine is about 42 per cent more expensive at 300 r.p.m. and 30 per cent more costly at 100 r.p.m. than a 60-cycle machine for the same output, voltage and number of phases.

Discussion.

In reply to questions, Mr. Fechheimer said that in armature design formerly 500-amp to 600-amp conductor per inch had been used, but that it is possible to get good insulation and increase this constant. Nearly all 300-r.p.m. machines are for water-wheel connection and, therefore, the bases, shafts and bearings must be furnished with them; while 100-r.p.m. machines are for engine drive and the engine builder furnishes the bases, shaft and bearings.

IRON LOSSES IN DYNAMOS.

Mr. I. E. Hanssen, of the Westinghouse Electric & Manufacturing Company, gave an outline of the causes to which may be attributed the increase in actual iron loss above the value calculated from iron-loss curves applied to dynamo-electric machinery. On account of lack of uniformity of flux distribution when toothed armatures are used, the loss in the iron back of the slots is about 30, 35 and 40 per cent for 25, 40 and 60-cycle machines, respectively, above the value calculated for uniform flux. The losses in the teeth will be 30, 60 and 80 per cent larger for 25, 40 and 60-cycles, respectively. The slot openings cause a high-frequency variation in the flux density; the loss occasioned thereby can be calculated from test data obtained on machines already constructed, although values were not specified by the author.

Discussion.

Mr. A. E. Averrett considered the statement concerning the effect of a slight cut in the lathe increasing the surface losses about 50 per cent open to discussion. He believed that grinding is more serious than turning, but if properly done, not serious, while filing is. Silicon steel in high-frequency machines decreases the losses and appears profitable to use. Prof. V. Karapetoff believed that a safe procedure in estimating iron losses is not to depend upon measurements obtained from stationary samples, but to obtain data from actual machines. Mr. H. M. Hobart approved of the latter method. He also called attention to the pictures of lines of magnetic induction, and states that they are, of course, not pictures of magnetic lines, but photographs of colored fluid between plates of glass so arranged as to make the analogy reliable.

AUXILIARY-POLE MACHINES.

The designing and testing of auxiliary poles for direct-current machines were treated in a paper by Mr. John N. Dodd, of the New York Public Service Commission. After discussing commutation phenomena as affected by auxiliary poles, the author arrived at the conclusion that poor commutation in a direct-current machine is due to the fact that the coils undergoing commutation are in the magnetic field produced by the armature magnetomotive force, which is identical with armature self-induction. He stated that when this field is annulled so that the current can be collected according to Ohm's law, the commutation is perfect. This condition exists when a direct-current voltmeter registers zero volts between points on the commutator under the brush.

Discussion.

Mr. C. J. Hopkins asked what effect the bearing wear might have. He quoted English practice and mentioned that the use of ball bearings had given twice as much life as plain bearings. Prof. V. Karapetoff said that the leakage is considerable between the main pole and the auxiliary and must be taken into account; he also asked in what respect Mr. Dodd's method differed from that of Hobart, and if so what is his criticism of the latter.

Prof. C. A. Adams said that Mr. Dodd had brought up an old

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point of discussion, which is, namely, the separation of the main armature flux from the short-circuit flux of the coil. Professor Adams favored such separation because owing to the characteristics of design there is a considerable pulsation at the point of commutation; that is, the designer must take into account the so-called reacting forces.

Mr. Dodd said that in regard to railroad motors ordinarily mechanical considerations are the limiting conditions of air-gap limits. The use of auxiliary poles to cut down the cost increases the weight. The measurement of volts per bar is a fairly easy matter as one can measure the average voltage with a low-reading voltmeter. He had not noticed any special difference in the iron loss, but a decided difference in the leakage. There is nothing novel in his method, although he had worked this out for himself, but originality is claimed in the measurement proposed. The calculation of flux due to the reversal of current is the whole thing; in other words, the auxiliary pole produces an annulling flux. If the stability factor is poor, the cross-field is very marked.

ELECTROMOTIVE FORCE WAVE-SHAPE IN ALTERNATORS.

Professor Comfort A. Adams, of Harvard University, read a paper in which he applied the method of combining the e.m.fs. of single-armature conductors to determine the resultant e.m.f. of the whole armature winding of an alternator. In carrying out this method, he analyzed the electrical space distribution curve of the field flux into its fundamental and its various harmonics. On the basis of similarity of the electrical time-wave of the e.m.f. of each conductor and the electrical space-wave of the field flux, he made a vector addition of the fundamentals of the proper slot e.m.fs. to obtain the fundamental of the e.m.f. of the whole winding; a similar treatment was given to each harmonic, and the terminal e.m.f. was found as the resultant of the fundamental and the several harmonics. On account of what was termed "belt differential, pitch differential, mid-coil differential and phase differential" actions, the harmonics in the space-wave of the flux appear in reduced form in the time-wave of the alternator e.m.f. By a proper choice of windings so as to obtain certain combinations of the various differential sections, it is possible to reduce all of the harmonics in the e.m.f. time-wave to very low values, even when the space distribution of the flux is far from being sinusoidal.

POLE-FACE LOSSES.

Messrs. C. A. Adams, A. C. Lanier, C. C. Pope and C. O. Schooley, of Harvard University, reported the results of an investigation of the losses in the pole faces of generators and motors. Use was made of a machine having detachable poles and pole-shoes, and three armatures, each with a different number of teeth. Three sets of pole-shoes were used, one set being of solid annealed steel casting, one set of 0.014-in. laminations, and the third set of 0.06-in. laminations. The air-gap was varied by means of shims placed behind the pole-pieces. The pole-face losses were measured by running the machine light as a motor, measuring the input and subtracting the other losses.

On account of the lateness of the hour it was impossible to discuss this paper, but Messrs. Osgood, Rushmore and Steinmetz congratulated the author upon its usefulness, and the last speaker stated that it marked a classic advance in the art.

Operation of Electric Apparatus.

UNBALANCE OF VOLTAGE IN POLYPHASE MOTOR.

Messrs. S. B. Charters and W. A. Hillebrand, of Stanford University, in a paper read by Mr. Charters reported the results of tests relating to the reduction in the permissible output of polyphase motors due to an unbalance in voltage. The tests showed that unbalancing of voltage and shift of phase tend to cause serious overheating in polyphase motors. Where it is possible to separate the effects due to phase shift and voltage unbalance, phase shift is found to be relatively of more importance. The reduction in permissible load due to either phase shift or voltage unbalance varies approximately directly with the cause. In the induction motor the existence of phase shift and voltage unbalance causes a worse performance than would be expected from either irregularity alone, whereas in the synchronous motor the reverse is true. The performance of the induction motor supplied from an unbalanced circuit is materially affected by its design.

Discussion.

Mr. R. E. Hellmund, Pittsburgh, pointed out that the interchange of heat between the various stator parts is comparatively good as a rule, since coils and iron are at about the same temperatures when tested, no matter how the losses are distributed between the iron and the copper. Most motors will withstand a certain amount of unbalancing without any reduction in rating. The amount of unbalancing usually decreases with the loads, and is, therefore, smallest for the overload; that is, for the condition for which increased heating through unbalancing is the least desirable. Unbalancing depends on the design of the motor as well as the unbalancing of the voltage. The no-load reactance current is, therefore, most affected. Mr. Abell pointed out that unbalancing is very serious in its effect on the heating. Almost any three-phase motor will give 40 per cent of its output when run single-phase. Mr. A. M. Dudley, Swissvale, Pa., touched upon the relation of torque to the square of the voltage. Mr. J. C. Parker, Rochester, N. Y., said that the commercial side of unbalancing is serious. Many hydro-electric companies require a clause in their "power" contracts calling for a balanced load, otherwise the consumer may be penalized.

Dr. Steinmetz emphasized the importance of defining the torque meant in considering induction motor phenomena. The maximum torque of a motor varies with the square of the voltage, while the safe heating torque varies not in proportion to either the voltage or its square—the heating depending on the current and magnetic flux. The maximum safe heating torque is greatest at a certain voltage. If the voltage is high in one phase there is a shift of the magnetic field. The torque falls off at constant heating only very litte with unbalancing of voltage. The design of the motor affects the unbalancing. Local heating may be troublesome and the relations very complex.

Mr. C. F. Scott suggested that it is dangerous to apply the results of this paper promiscuously. The practical point is the effect of the unbalancing upon the safe capacity of the motor. Sometimes the heating of the motor is not the limiting condition. Regulation may be the point at issue. Unbalancing may make it difficult to start. The motor acts as a transformer. Energy may be transferred from one circuit to another. Motors differ among themselves in both temperature distribution and their excellence as transformers, tending to equalize unbalancing between circuits. A small motor may have more difficulty during unbalancing than does a large machine. Mr. H. L. Wallace, Cleveland, cited a case where the voltage dropped on two phases and rose on one in unbalancing at a motor.

SURGES IN CABLES.

A paper by Messrs. E. E. F. Creighton and S. D. Sprong, of the General Electric Company, was devoted to an experimental investigation of the surges in the underground 2300-volt, three-wire, two-phase system of the United Electric Light & Power Company, of New York City. During the investigation use was made of aluminum-cell surge protectors, and spark-gaps were inserted at different points to indicate excess potentials. Surges were produced artificially by starting an arc between one phase lead and ground. Oscillographic records were made of the voltage across a potential regulator coil, the current in the grounded leg of the surge protector and the current in the spark-gap circuit to ground. The records showed that the energy of the static charge of the cable passes into electro-magnetic energy in the potential regulator and is re-transformed from one to the other until dissipated. When the number of feeder cables connected to the same busbar was increased, it was found that the "natural frequency of oscilla-

tion" diminished with each additional feeder, while there was an increase in the current through the arc to ground. During normal operation the surges seldom reach potentials much greater than twice the normal.

Discussion.

Mr. J. L. R. Hoyden, Schenectady, described some experiments made in Schenectady to illustrate the protective value of the aluminum cell arrester in cases of artificial resonance and surges. The phenomena were illustrated by oscillograms. Mr. H. W. Fisher, Pittsburgh, commended Mr. Sprong for the financial risks assumed in making the tests described in the paper. Mr. J. B. Taylor, Schenectady, asked about the decrease in frequency as feeders were added. He stated that there is a tendency to overestimate the dangers of harmonics in commercial service. Mr. R. D. Mershon asked about the form and character of construction of the aluminum cell arresters. Dr. C. P. Steinmetz said that the frequency decreased with the number of feeders in circuit, since there were from 1 to 12 feeders, each with its potential regulator and all in multiple through single regulator to ground, all being thus in series with a constant inductance. In closing, Professor Creighton said that the 13th harmonic may be brought out by a proper length of arc connecting to the ground or by proper inductance and capacity combinations. It may appear at any time. There are three types of aluminum cell protectors. The first has vested plates and a series gap set at about 25 per cent above line voltage. The normal construction gives 30 minutes' operation without damage to the arrester. The lower voltage arresters operate longer, having a large surface for heat dissipation. In one case 110,000 volts applied 40 minutes gave 18 deg. rise of temperature at the top of the oil. The second type of arrester is for direct-current service, having no series gap. One of these operated at 300 volts had an internal loss of 0.3 watt. The third type consists of a number of cells in series direct connected to the line. There is more loss of energy than in the direct-current arrester. A potential regulator or auto-transformer is put across each cell. At double voltage these cells discharge at from 200 amp to 400 amp, and at about 0.1 amp to 0.2 amp at normal voltage. The larger the plate area the more discharges one gets at double potential. If the cell is too small it will still cut down the peak, reducing the amount of the surge. Some cells have had five times normal voltage upon them for a short time, without trouble. The cells became luminescent, and a surface arc apparently formed. The cells divide the voltage fairly well, but the use of the auto-transformer enables a better operation to be secured. The film consists of a skeleton part, which takes a long time to form, and a gas or liquid which dissolves out if the cell is let stand without current or if current is reversed in it. A higher radiating surface can be obtained by immersing the cell in oil. The gap should be closed once a day by a switch provided, since each day that the cell stands the initial current rush is greater.

Dr. Steinmetz then explained with diagrams the action of the aluminum cell arrester.

Transmission and Distribution.

HIGH-TENSION TRANSMISSION LINES.

Mr. Percy H. Thomas, consulting engineer, presented two papers dealing with transmission systems. In one, the author derived a formula for calculating the true current, voltage and power factor at the generator end of a transmission line when the current, voltage and power factor at the receiving end are known. The second paper discussed the output and regulation in long-distance lines. The author suggested the use of inductance coils shunted across the transmission line to consume lagging current to balance the normal leading exciting current, and advocated dividing each transmission conductor into several wires in order to control the "ratio of the line inductance to the line capacity." Non-synchronous (induction) generators were suggested for the power house where it is desired to supply leading wattless current from the receiving end of the line, the synchronous apparatus at the receiving end serving for controlling purposes.

Discussion.

Prof. Thomas R. Rosebrough, University of Toronto, presented the following equations, with the Steinmetz notation, for complex quantities, E_1 and I_1, E_0 and I_0, describing the voltage and current at the transmitting and receiving ends of the line, respectively, which he considers simpler to apply than the method given in the paper:

$$E_1 = E_0 + 2\,I_0 + \tfrac{1}{2}\,2yE_0 + \tfrac{1}{8}\,2^2\,yI_0 + \ldots$$
$$I_1 = I_0 + 2\,yE_0 + \tfrac{1}{2}\,y2I_0 + \tfrac{1}{8}\,y\,2^2E_0 + \ldots$$

He stated that these equations are also more general because leakage conductance is accounted for. In using them one approaches greater accuracy, as each term is included, stopping as soon as any term calculated is found to be of small value. He then showed how Mr. Thomas, by making certain replacements in his final expressions, could include the effect of distributed leakage and obtain results of equal generality. He advocated the calculation of a three-phase circuit per se. as a star grouping of three transmissions instead of in terms of fictitious single-phase circuits.

Dr. A. E. Kennelly, of Harvard University, criticised Mr. Thomas' formulas on account of their length, which increases the chances of numerical error. He then discussed the application of hyperbolic formulas to line calculations (see *Electrical World*, Jan. 6, 1894, and *Transactions*, A. I. E. E., Vol XII, page 133). Dr. Kennelly said that the paper will be of use to engineers, if only in the collection of formulas which it exemplifies. He pointed out that hyperbolic trigonometry is as easy as circular trigonometry and readily applicable to alternating-current line work. He concluded with a discussion of the fact that the linear capacity in c.g.s. electrostatic units is the reciprocal of the external linear inductance in c.g.s. magnetic units. This enables one to choose, in any uniform distribution of overhead line conductors, split or unsplit, whether we shall compute the external linear inductance of the system, or the linear capacity, and then the other quantity follows as a simple reciprocal.

Prof. Vladimir Karapetoff stated that the first paper is prophetic in its importance. He suggested as to the second paper, on calculating lines, that engineers will find Professor MacMahon's book on hyperbolic functions very useful to engineers working in this field. Some may prefer Dr. Steinmetz's logarithmic treatment of complex quantities. Thomas' treatment is legitimate and useful, but no single method is the only one worth while. Mr. J. B. Taylor, Schenectady, touched upon limitations other than the cost of copper in practical cases of alternating-current transmission. Inductance can be reduced by multiple circuits or by splitting conductors, but at considerable financial cost.

Prof. D. C. Jackson, of the Massachusetts Institute of Technology, approved the use of the terms "lagging" and "leading energy." Formulas are needed for problems of network distribution. Dr. Steinmetz presented equations last year which add to knowledge, but which are not satisfactory to the computation needs of the working engineer. Modern transmission is tending toward overhead or underground networks. We must often depend upon the receiving station to take care of its own primary voltages. Mr. Thomas was justified in using circular trigonometry. The paper makes a start toward the computation of the great projects of the future, where power networks are likely to cover great States, and perhaps national areas. Inductance and capacity must be considered as distributed.

Dr. C. P. Steinmetz commended the use of the terms "leading" and "lagging power." Reactive power is an existing absolute quantity. There is no such absolute thing as leading or lagging "current." The magnetizing current is only wattless with reference to the induced e.m.f. In a 700-mile, 60-cycle transmission, if the current and voltage are in phase at the generator, then at the receiving end the current will be about 90 deg. out of phase with the generator voltage, but in phase with its own voltage at the receiving end of the line. The terms

"lagging" and "leading current" are misleading. For economical transmission it is necessary to balance the lagging and the leading energies. One must have methods of controlling the power factor and voltage at the receiving end in these long lines. In railway transmission with rotary-converter substations, the phase relations are automatically varied from lag to lead. An approximate method of considering capacity is to assume it as concentrated at the generating end, and then at the receiving end. By averaging these two results one gets closer figures than where the capacity is assumed as located at the middle of the line. When the charging current runs from 10 to 30 per cent of the full load of the line these approximations are sufficient, but above this one needs the intricate formulas.

Mr. P. M. Lincoln, Pittsburgh, said that the paper is chiefly of assistance for the distant future. Mr. Thomas has really made careful analysis of a certain type of resonance. Mr. R. D. Mershon then said that a synchronous motor at the end of the line is not exactly like a condenser, since the inherent regulation is a function of the line and the machine. The mechanical objections to the use of a split conductor are considerable. The cost would tend to run high and the possibilities of trouble from sleet might be considerable. Mr. H. W. Fisher, Pittsburgh, said that some of his tests on a line having 85 per cent power factor at the distant end, with high capacity and low self-inductance, gave a power factor close to 100 per cent at the generator end.

Prof. J. B. Whitehead, of Johns Hopkins University, stated that the author has performed valuable service in presenting his rare formulas as checks upon the use of the split capacity formula. However, the losses between lines, over insulators, etc., have been neglected. These would appear as parallel-connected resistances if developed in a formula. Subdivision of wires would lead to increased insulator loss and circulating or secondary currents in one line's branches due to inductive action of the others. A series of accurate measurements on existing lines would be helpful. He criticized the language of the paper as somewhat confusing in places, and made a plea for the retention of current and e.m.f. as standards of reference where variation with time is involved, and the direction of the resultant flow of energy where variations in space are involved, as in Bynting's theorem based on Maxwell's equations.

Mr. C. F. Scott, Pittsburgh, said that the author deserves credit for his careful extended analysis of the simple conditions assumed. As distances and voltages increase quantities and conditions once of minor importance become very significant. If the line conditions are established for full load it is of minor consequence what happens to efficiency at the lighter loads. A synchronous machine at the end of a line is not dependent upon the various currents and voltages coming in over the line. Possibly two wires would answer nearly as well as three in splitting conductors.

Mr. Thomas, in closing, said that he had tried to simplify the work as much as possible. He referred enthusiastically to Dr. Kennelly's fine work on the subject in 1895. There would probably be a gain in the leakage into air by the use of a conductor split into three parts. He could not see that there would be much increase in expense of labor for stringing three conductors making up No. 0000 section compared with erecting the single cable.

EVEN HARMONICS.

A paper by Mr. J. B. Taylor, of the General Electric Company, discussed certain of the conditions under which even harmonics are produced in alternating current circuits. They exist when an alternator has an unsymmetrical winding with unsymmetrical poles; when a three-phase system is operated with the neutrals grounded at both ends and direct current is in the ground. The direct current gives biased magnetization to the core, and the primary current possesses an unsymmetrical time-wave shape. However, the extra heating produced by the direct current in the transformer circuit will seldom be of such value as to affect the operation of the equipment.

Discussion.

Prof. F. Bedell, Cornell, said that direct current in the transformer increases the iron and the copper losses less than is usually supposed. Twenty per cent direct current increases the effective value of the alternating current only 2 per cent. Professor Karapetoff, Cornell, showed mathematically why it is impossible to get direct current from an alternator without a commutator. The even harmonics induced in consecutive conductors are mutually cancelled. Mr. C. F. Scott, Pittsburgh, referred to early experiences with rotary converters and also mentioned the case of a transformer which had a small output for its voltage relations, and considerable resistance in the primary circuit. When direct current got into the secondary circuit the magnetizing current reversed and did damage. Dr. Steinmetz said that with the same height of cycle the hysteresis losses are the same, regardless of the symmetry of the wave. Eddy currents are probably increased by the greater abruptness of the change. Even harmonics are probably as frequent as odd harmonics. The constant term, which is the first term of the even harmonic, cannot exist in a machine without a rectifying device.

IMPEDANCE OF ARMORED CONDUCTORS.

Prof. J. B. Whitehead, of Johns Hopkins University, described calculations and measurements made upon certain armored conductors when used as single conductors widely separated from the return circuit. The calculations show that the reactance of the usual type of single-conductor, iron-armored cable may be from 2 to 4.5 times that of unarmored cable, depending on the distance to return conductor; the factor increases with decreasing distance. In cables as manufactured the reactance is about 0.7 of the maximum theoretical value. The effective resistance as measured varies little with the distance to return conductor and is about 1.6 and 2 times the dead resistance at 25 and 60 cycles, respectively, and a current density of 1 amp per 1000 circ. mils. The impedance for distances under 12 in. is about 3 times the dead resistance at 60 cycles and 1.7 to 2 times the dead resistance at 25 cycles. With the sheathing and the armor grounded at both ends the impedance is somewhat lessened and is largely of the nature of resistance. The impedance of a double-conductor, iron-armored cable, with conductors located 0.873 in. apart between centers, and at the current density given above, is about 7 per cent greater at 60 cycles and 3 per cent greater at 25 cycles than the calculated value. The increase is in effective resistance, due to eddy curents in the lead sheathing.

There was no discussion on this paper.

LOSSES AND CURRENTS IN METALLIC COVERS OF CABLES.

Mr. H. W. Fisher, of the Standard Underground Cable Company, presented a paper giving a large amount of data relating to the losses, induced volts and amperes in the armors and lead covers of cables. In certain single-conductor cables covered with lead and bound with steel wires, the total loss was double the loss in the conductor alone. In a certain lead-covered copper-armored cable the effective impedance was found to be greater when the lead circuit was connected at both ends of the cable than when not so connected. The conditions under which such a result is obtained were discussed mathematically and graphically. The tests on a No. 0 single-copper conductor lead-covered cable armored with steel tape showed that the impedances are greatest when the armor and lead are not connected and that a sharply defined maximum is reached with a conductor of about 80 amp. Short-circuiting the armor at each end of the cable decreases the impedance only slightly. However, when both the lead cover and the steel armor are short-circuited, the impedance is very much reduced and it varies only slightly with the value of the current in the conductor. In such a cable the impedance may be 13 times the conductor resistance when the cover and armor are disconnected; when they are short-circuited the impedance may be only 3.5 times the conductor resistance.

Discussion.

Mr. R. D. Mershon, New York, spoke of certain difficulties in finding any sheath losses in three-conductor, three-phase cables. Mr. Fisher cited a case where there was a 10 per cent rise in ohmic loss over the conductor loss in a 500,000 circ. mil three-phase cable due to the induced loss in the sheath. Professor Whitehead cited the use of single-phase cables in a draw-

bridge installation as 50 per cent cheaper than multiphase cable construction for the same work. Dr. C. P. Steinmetz said that in steel-armored, single-conductor cable one may get high heating, impedance and resistance. These change with the bonding arrangement of the armor and conductor and the current. Single-conductor steel-armored cable is very undesirable, but when necessarily used the phases should be put very far apart and tests made over the entire range of normal and abnormal service conditions. A far better plan is to spend more money in a two-conductor cable.

INSTRUMENT TRANSFORMERS.

The errors encountered in making measurements by means of the so-called "current" and "potential" transformers and the methods for minimizing them were discussed in a paper by Mr. L. T. Robinson, of the General Electric Company. For measuring large alternating currents and voltages, "current" and "potential" transformers must usually be employed. If these are carefully designed they may be used with small errors resulting with various devices connected in the secondary circuit, and with primary current varying between the limits of the connected instrument scales, also with voltage and frequency variation usually encountered in practice. If some care is not used in selecting suitable apparatus to meet conditions, errors as great as 5 or 10 per cent or more may occur. If the transformers are constructed with special reference to handling a given load, the errors may be limited to almost any required amount. To meet conditions of testing where low power-factor is present, or where a high degree of accuracy must be attained, carefully determined corrections for ratio and phase-angle must be applied. Such corrections, once determined for any given transformer, are permanent, and by their use the transformers may be considered precision instruments. Wattmeters, when used without "current" or "potential" transformers, may be made to give indications correct within the limits of error of observation down to a power-factor as low as 10 per cent. Under certain conditions which may occur in practical work, it is well to know and apply corrections to the instruments themselves. If the conditions are such that the wattmeter must be corrected for phase-angle to insure suitable accuracy, "current" and "potential" transformers should not be used, unless the conditions are somewhat favorable, and the corrections for the transformers are determined and applied with great care.

Electricity in Rolling Mills.

STORAGE BATTERIES AT GARY.

The operation of the storage battery for regulating the load on the alternators at the plant of the Indiana Steel Company, Gary, Ind., was described in a paper by Mr. J. Lester Woodbridge, of the Electric Storage Battery Company. The battery is rated at 8640×1 amp-hours, although it can give a momentary output of 25,000 amp. Its e.m.f. varies from 200 volts to 225 volts. Two split-pole converters serve for transferring energy to or from the battery from or to the alternating-current system. The converters are operated as two-part pole machines. Two-thirds of each pole is subjected to constant excitation, obtained at 250 volts from exciter busbars, while the other third receives an excitation which varies with the load on the system. The latter excitation comes from an exciter whose voltage varies directly with the load on the alternating-current system, being zero at a specified mean load. Experience has shown that the battery maintains good voltage regulation and allows the rolling mill to be operated at its highest and most economical speed. Moreover, the battery is an ever present source of energy in case of some emergency such as the sudden shutting down of one of the prime movers or any other partial interruption of the supply. The necessity for continuous energy supply to a steel rolling mill is well understood. The author expressed the opinion that the effect of the battery in eliminating costly delays in the operation of the mill would warrant the fixed charges against the battery investment, even if these were not largely offset by the saving in investment for additional generators which the battery renders unnecessary.

FLYWHEELS IN ROLLING MILLS.

The advantages of employing flywheels in connection with electrically operated rolling mills were pointed out in a paper by Mr. H. C. Specht, of the Westinghouse Electric & Manufacturing Company, who gave an outline of a method for determining the effect of the flywheel on the performance of the driving motor. When a flywheel is used, the motor can be made much smaller, and even with the heavy additional flywheel the total cost for the complete motor outfit might be lower than for the larger motor without the flywheel. Moreover, the higher efficiency, higher power factor, and low average current make it possible to reduce the equipment of the generating plant and distributing system, while the operating expenses are lowered.

ROLLING-MILL MOTORS.

Mr. E. W. Yearsley, of the Midvale Steel Company, read a paper outlining briefly the features to be considered in driving a steel mill by electric motors. He said that for large main-drive motors the advantage of continuous running at constant speed is so great that it would appear advisable to make the design of the mill suit the characteristics of the motor, and avoid the extra expense and complication of devices like the reversing drive. There seems to be no great difficulty in designing mills for continuous-running motors. By combining such motors with a suitable flywheel, it should be possible to keep the line load sufficiently uniform. However, in some installations the flywheel has been so badly proportioned as to be detrimental to the operation of the motor. The controlling apparatus for mill service is usually the weak part of the system; it is much less satisfactory than the motors. Mechanical strength and simplicity are the main points to be observed in designing this apparatus. Heavier and more mechanical switches and circuit-breakers, better protected and more durable rheostats, and more dependable automatic controlling devices, requiring less attention, are badly needed. This is a problem more difficult of solution than improvement of the motor, but no less necessary.

ELECTRICALLY DRIVEN ROLLING MILLS.

A paper by Mr. E. Friedlander, of the Carnegie Steel Company, showed in what respects the electric motor is preferable to the steam engine for driving rolling mills. The author stated that the absence of the heavy and troublesome lifting tables in the non-reversing mill is a welcome feature of the reversing mill. Although the first cost of a reversing mill is higher, its lower depreciation, better operation and lower cost of maintenance should justify its installation. Operation of electric-driven reversing mills is nearly automatic; no skilled operator is required and all danger to the motor and the mill is eliminated. The speed of acceleration is prearranged, and no matter how fast the operator moves his levers, the maximum current and the speed are limited. Reversing is done with the least shocks in rolls and couplings and the danger of overstraining the machinery is eliminated.

POWER REQUIRED FOR ROLLING STEEL.

Mr. Brent Wiley, of the Westinghouse Electric & Manufacturing Company, presented a paper giving data relating to the power required for rolling high-carbon steel of small section. In the case of a steel containing 1.29 per cent of carbon there were required 71.2 kw-hours per ton of metal rolled from 5.5 ft. in length to 36.0 ft. Owing to the high percentage of carbon the harder steel billet must not be heated to as high a temperature as the milder steel, and it is rolled at a lower temperature at a greater cost for energy; however, for the same rolling temperature high-carbon steel requires no more energy than does ordinary mill steel.

CONTROL FOR ROLLING-MILL MOTORS.

Mr. C. T. Henderson, of the Cutler-Hammer Company, presented a paper describing the problems encountered in designing

controllers for rolling-mill motors and describing briefly the solutions obtained in certain instances. The prime requirement is continuity of service, since the loss from interruption of service in a blooming mill costs from $300 to $1,000 per hour. For the protection of both the motors and the rolls driven by them, use is made of controllers which automatically maintain the accelerating current between certain well-defined limits or adjusts it properly for the cycle through which the motors operate. At one blooming mill a certain 160-hp motor having a normal speed of 88 r.p.m. is required to accelerate to full speed ⅝ second run at full load for 1⅝ seconds and then come to rest in ⅝ second. The controlling apparatus has been so designed, with current limiting devices, that the cycle is completed without the motor requiring more than full-load current at any time. This motor operates the elevating table for a set of three-high rolls. The table weighs 118,000 lb. and is raised a total distance of 40 in. in 2⅝ seconds.

AUTOMATIC MOTOR CONTROL.

Mr. H. E. White, of the General Electric Company, presented a paper discussing the advantages of that type of motor controller which makes use of electrically actuated switches controlled by automatic or semi-automatic means. This type was claimed to possess the ability to control motors of any size with facility and with slight muscular effort; to control many motors from one conveniently chosen place; to control large motors from a distance with comparatively inexpensive connecting cables; to limit the current input to the motor, either during or after starting; to use sensitive devices, such as pressure gages or thermostats, to start motors operating machines such as pumps or blowers; to obtain "no-voltage release" and automatic re-starting features without additional complication; to secure interchangeability of parts to an extent not possible with any other type of control, and to secure automatic stopping by limit switches to prevent overwinding or to stop the motor at predetermined places.

Discussion.

The discussion of the above papers on the application of electric power in rolling mills, which were, with the exception of the paper by Mr. Woodbridge, presented at a special session, did not follow closely the subjects of the papers, and therefore it is given below without reference to the titles of these.

Mr. D. B. Rushmore, Schenectady, said that in rolling mill practice there are as wide fluctuations in load and through as great magnitude as in any other classes of industrial service. We have the very exacting condition of a prime mover working at best efficiency through a narrow range of output and perhaps not the best regulation. Continuous operation is necessary also. Turbines floating on the line may be used as over-excited synchronous motors to load down the prime movers to the point of constant output. The solution at Gary was the most desirable one. In answer to a question by Mr. Edward Van Wagenen, New York, Mr. Woodbridge said, in closing, that the voltage regulation at Gary is excellent.

Mr. D. B. Rushmore, Schenectady, said that the object of these papers was to bring out a discussion upon the most interesting phase of present industrial power work. He urged the steel-mill men present to bring out at Institute meetings the engineering features in which they are interested. Steel mill operating engineers and the manufacturing engineers should co-operate. Reliability is the greatest requirement of steel-mill work. Too much stress upon price always means a certain sacrifice of engineering features. In steel work the value of the output is great in comparison with the value of the machinery. The engineer of the steel mills is the man to buy the apparatus, rather than the purchasing agent. The development of the control is one of the most important phases of the subject. We are entering an era when practically all the steel mills will have to be electrified in order to meet competition. Mr. C. F. Scott, Pittsburgh, endorsed Mr. Rushmore's remarks. In no field has electrical development been as rapid as in the steel mills. The electric furnace is coming into steel making more and more; the electrical engineer is occupying a controlling position instead of one that is auxiliary.

Mr. R. Tschentscher, of the Illinois Steel Company, South Chicago, presented a typewritten discussion of electric power problems in steel mills. He classified the mills, and cited the South Chicago plant as an example of a self-contained installation supplying power to other industries. The evolution of the plant is illustrated by a capacity 10 years ago of 160 kw compared with a present capacity of 26,000 kw. To-day's installation includes 2000 motors, having a total rating of 75,000 hp, a 1200-kw storage battery outfit, 7000 kw in converting apparatus, and 33,000 kw in transformers. He then discussed the enormous waste of heat in a steel mill. One of the services of this plant is to supply power to 7000 kw of induction motors driving a cement mill 11 miles away. The power factor was 70 per cent, but two 1650-kw synchronous condensers are being installed at the end of the line to improve conditions, the guaranteed saving being $10,000 a year in the net cost of power at the delivery point. A 15-ton, three-phase electric furnace has been in operation in South Chicago for two months, supplied with power from three 750-kw, 25-cycle, 2200-volt to 100-volt transformers. The amount of power required for electric steel furnace service of 4000 tons per day capacity would be about 25,000 kw. The speaker believes that electric steel making will soon be in general use. A typical self-contained plant having a capacity of 2,000,000 tons per year, including cement manufacture also, would require 100,000 kw in machinery, using no coal and depending upon blast furnace and coke-oven gases. The steel-mill engineer must be about 60 per cent business man and 40 per cent engineer. He still has the sentiment of the rolling mill superintendent to contend with, and if any man on earth must be "shown," he is the one.

Mr. K. A. Pauly, Schenectady, emphasized the value of non-automatic control for rail-mill motors over a limited range, say of from 10 per cent to 15 per cent. Referring to Mr. Specht's paper, he said that in determining the capacity of a fly-wheel, the cost of power, the generating station and the rolling-mill motor enter. The economical size of fly-wheel is greater where the power cost is high or where the over-load capacity is small. As the number of mills driven from a single station increases, the station peaks decrease, and the extent of fly-wheel capacity necessary tends to go down. Mr. J. C. Parker, Rochester, N. Y., emphasized the importance of Mr. Specht's paper in central-station work. Fly-wheel apparatus had wide importance in smaller service where motors are applied. The effect on the central station is of less importance than the quality of service rendered at the machine. He questioned the advisability of the independently driven fly-wheel.

Mr. C. F. Scott, Pittsburgh, reviewed the early history of steel-mill motor designs, pointing out the importance of an extremely reliable machine for this service. Continuity of service is of enormous importance. The peculiar conditions of power supply and the fluctuating load call for the broadest kind of engineering. The cost of power is not the vital point. Mr. Tschentscher saved $1.50 per year per motor horse-power, but in this case the power factor increased the cost of the power only from 5 per cent to 10 per cent. Savings in labor and increase of output would overbalance the saving in power. Effective operation was the important point. Discussing Mr. Friedlander's paper, Mr. Scott said that the electric drive and measurements enabled one to study the performance of the rolls quantitatively and to check the condition of equipment and study the conditions of mill work in a scientific way. The machine shop offers an analogous case. The reason for the electric drive is the increased output possible rather than the economy. Much will be gained by centralizing the power in a steel mill and applying electrical distribution.

Mr. Specht said that a separate fly-wheel was installed in a case described by him because the electrical design of the motor did not take such a device into account. He thanked Mr. Rushmore for getting the rolling mill and electrical men together. Mr. H. E. White, closing, said that in regard to the use of a

dynamic brake in connection with a wound secondary of an induction motor, there is no present means of bringing such a machine to rest by alternating current without imparting a tendency to start it in the opposite direction. Mr. A. M. Dudley pointed out that there is no advantage in weight in using a separate fly-wheel, but that the motor can be built somewhat lighter. It is not difficult to stop a direct-current motor by putting direct-current into it. Mr. C. T. Henderson, in closing, said that a peculiarity of English instruments is that the scales read from right to left. The automatic slip regulators at Gary have been criticised as being too slow, but if it had been desirable, their action could have been quickened by the use of current relays operating directly on the contractor windings. He could not agree with Mr. White that direct-current contractors are slower than alternating-current contractors. If it were so, it could easily be corrected by a permanent resistance in the contractor winding. Neither did he agree with Mr. Yearsley that the controlling apparatus is not as reliable as the other equipment. It is necessary to have adequate apparatus to limit the motor current in rolling-mill practice, since the mill cannot stand the time required for a circuit-breaker to go out and be re-set. At this point Mr. White interjected a good word for the alternating-current contractor. Mr. W. L. Abbott, Chicago, outlined a method of calculating fly-wheel sizes by averaging a power wave diagram. Mr. J. C. Parker, Rochester, said there is a blast furnace plant on the Niagara frontier taking 16,000 hp from an outside source. The interests of the central station and the steel mill may not be far apart. The Solvay people have utilized some of their by-product power for industrial service.

Miscellaneous.

CONVECTION OF HEAT FROM WIRES.

In a paper by Messrs. A. E. Kennelly, C. A. Wright and J. S. Van Bylevelt, of Harvard University, were reported the results of experiments relating to the convection of heat from small copper wires. The tests were conducted by varying the atmospheric pressure surrounding the wire, under conditions of free convection, and by subjecting the wire to varying wind and velocity under conditions of forced convection, in each case measuring the change of electric power required to maintain the wire at constant temperature elevation. Use was made of wires of small diameter in order to minimize the loss by radiation. Wires having diameters of 0.0114 cm, 0.0262 cm and 0.0691 cm had linear convections of 5300, 5600 and 8500 abwatts per centimeter per degree centigrade at atmospheric pressure. The experiments showed that the convection varies directly with the square root of the wind velocity when forced cooling is employed. The free convection from the wires at rest corresponded to a forced convection at a virtual wind velocity of about 25 cm per second. If this velocity be added to all the actual wind velocities in forced convection tests the linear convections conform satisfactorily to the law of square roots of wind velocity from 2000 cm per second down to 0 cm per second. The results were expressed as empirical formulas.

Discussion.

Prof. Vladimir Karapetoff, of Cornell University, asked if the formulae for free and forced convection near the end of the paper could be evaluated by other than the method of least squares. Dr. Charles P. Steinmetz, of Schenectady, N. Y., said that while a corrective term in a formula is annoying, the parabolic law can be obtained by the interpolation of the logarithmic curve. Mr. C. F. Scott, Pittsburgh, Pa., suggested that the experiments may be somewhat affected by the movement of the heated air in the free convection tests, which would give a relative velocity to the wire and air, even when the former was suspended in a closed vessel. Mr. P. M. Lincoln, Pittsburgh, pointed out the value of the paper in the scientific study of ventilation in electrical machinery. Dr. Kennelly closed the discussion by emphasizing the semi-physical nature of the paper, the need of using units consistently and in accordance with scientific conceptions. The parabolic term is preferable to the word "exponential" as used. No labor would have been escaped by defining the atmosphere otherwise. Except at low speeds the convections of the logarithmic curves are small.

TELEPHONE CABLES.

A paper by Mr. Frank B. Jewett, of the American Telegraph & Telephone Company, discussed the characteristics of the modern telephone cable and outlined briefly the cable specifications employed by the associated Bell companies. The specifications require each conductor to be insulated with a single wrap of paper spirally applied. Between each conductor and all the rest and the cable sheath the insulating resistance must be not less than 500 megohms per mile of cable at 68 deg. Fahr. The insulation of each conductor must withstand a potential of 500 volts without rupture. The mutual electro-static capacity of any pair must not exceed certain specified values—0.084 microfarad per mile for a 300-pair cable and 0.079 microfarad for a 240-pair cable. The core must be enclosed in a sheath composed of an alloy of lead with not less than 3 per cent of tin.

THE TRAINING OF NON-TECHNICAL MEN.

The training of non-technical men as conducted at East Pittsburgh was outlined in a paper by Mr. C. R. Dooley, of the Westinghouse Electric & Manufacturing Company. The work is accomplished by means of an apprenticeship system and by a night school. The apprentices receive instruction both in the shop and in the class-room, the class work including mechanical drawing and shop arithmetic. The night school, which requires 25 instructors, has an enrollment of about 300 students, practically all of whom are employed in the shops for nine and three-quarters hours per day, besides attending school for three hours on three evenings of each week. Only ambitious boys undertake this work, and the results have been very gratifying.

CLASSICS IN ENGINEERING EDUCATION.

Dr. C. P. Steinmetz, of the General Electric Company, presented a paper briefly outlining the value of the classics in engineering education. He expressed the opinion that the neglect of the classics is one of the most serious mistakes of modern education, and that the study of the classics is very important and valuable, and more so in the education of the engineer than in most other professions, for the reason that the avocation of an engineer is specially liable to make the man one sided. By dealing exclusively with empirical science and its applications, the engineer is led to forget, or never to realize, that there are other branches of human thought besides empirical science, and equally important as factors of a broad general education and intellectual development. It is true that the classics are not necessary if the aim is to fit the student to ply the trade of engineer, just as that of plumber or boiler maker, and the world, and especially the United States, is full of such men who have learned the trade of engineer. However, such learning of the engineering trade can hardly be called receiving an education, and certainly does not fit the man to perform intelligently his duties as citizen of the Republic during the stormy times of industrial and social reorganization which are before us. Dr. Steinmetz said that the modern languages are not in the same class with the classic languages, and he considers them of practically no educational value. Their utilitarian value to the college student is negligible, for on account of the limited time, the absence of practice, and the large number of other more important subjects of study, very few of the college graduates retain even a rudiment of their knowledge of modern languages, and even those few do so only because they are especially interested in them, have occasion to practice them, and therefore would probably have learned them outside of college. To the engineer particularly, the knowledge of foreign modern languages offers no appreciable help in following the engineering progress of other countries, because practically all that is worth reading is translated into English either in full or in abstract. Since the modern languages have no appreciable educational value, they should be dropped from the engineering curriculum of the college

Discussion.

The papers by Dr. Steinmetz and Mr. Dooley were discussed together. Mr. Dooley said that the fundamental idea of the night school is to train men in a broad way. Dr. Steinmetz stated that his paper grew out of his interest in recent discussions of the sphere and qualifications of the engineer, and referred to the recent Institute paper of Mr. F. P. Fish on the subject of patents as an example of a contribution which no mere engineer could have written. The unsatisfactory position of the engineer in public life is largely due to ourselves.

President Ferguson referred to Mr. Fish's paper as one of the best ever presented before the Institute. He read a letter from Mr. Fish, who said that he felt the obligations of the Institute to Dr. Steinmetz for calling attention to this subject. He concurred in the general conclusions of the Steinmetz paper. He considered it most unfortunate that engineers do not have the opportunity to study the great authors of Greece and Rome. It is broadening to become saturated with the modes of life of other civilizations. The classics better fit a man to judge human nature and affairs. The great difficulty is that few men in active work have the time for such studies. The curriculum cannot be made long enough to inculcate even the principles of engineering. Mr. Fish said that he personally owed more to the work he did to the classics than to any other branch.

Prof. C. A. Adams, of Harvard University, voiced his appreciation of Mr. Dooley's paper and work. A new attitude on the part of the manufacturing companies is that of taking account of the efficiency of the human machine. He doubted the value of the classics in immediate relation to engineering education. Individual tastes vary widely. It is not so certain that a narrowness of concentration is undesirable. Mr. C. F. Scott, Pittsburgh, referred to recent papers before the Society for the Promotion of Engineering Education and commended the process of self-sorting which goes on in Mr. Dooley's school. The work lifts up men who have not had technical advantages. He referred to the necessity of the engineers being able to solve broad problems, and said that Dr. Steinmetz is speaking for a broader view of affairs than is sometimes considered possible. The classical man deals with the speculative or philosophic situation, while the engineer deals with facts.

Mr. Farley Osgood, general superintendent of the Public Service Corporation of New Jersey, emphasized the need of the specialist in the designing engineer. In the operating company the greatest difficulty is to get young college men who can think quickly, rapidly and accurately. Designing engineers get into ruts and are anxious to become specialists because of competition. The operating man must meet the public and handle financial problems as well as technical questions, and make his boards of directors give up money in lines of business that they do not understand. Too many engineering graduates think they must go into the factory, but while this is well, there are other things in the world than making machines. In many cases it would be desirable for the college graduate to come directly into the operating company. Mr. Osgood said that his engineers frequently go to the colleges to get the men direct and thus save the four years spent in the factory. The professors are apt to have too little knowledge of the great breadth of work done by the operating engineer.

Dr. M. G. Lloyd, Washington, said that the condition which Dr. Steinmetz mentions is general among all Americans. The classics are extraneous to the technical part of education. Languages should be put down into the lower schools and the sciences taken out of them. In the technical school, technical education is the main issue, and in teaching any subject more depends upon the instructor than upon the subject. Mr. John C. Parker, Rochester, said that Mr. Dooley's work does away with class consciousness and would be justified on that basis alone. Social and economic problems, managerial and financial work are scientific in character, if not belonging to the exact sciences. Mr. D. B. Rushmore, Schenectady, said that man's first object must be a source of income. Whatever else education does, it should provide that. The college education is only the base of a pyramid which we wish to build high. If the base is too broad one cannot reach the height soon enough, and if it is too narrow the pyramid becomes unstable. The man who is to be purely an engineer must confine himself closely to technicalities. Dr. C. H. Sharp voiced the need of men of various sorts and degrees of training; he did not agree that the classics furnished the best way of securing breadth. It may be possible to over-rate the value of the classics. Little can be done in a short time with languages. In many cases it costs too much to take the kind of work Dr. Steinmetz lays out. Higher professional training leading to the degree of doctor of engineering is very desirable.

Mr. J. G. White, New York, said that the alpha and omega of the engineer is presented in the two papers. Only a few can take such broad training as Dr. Steinmetz recommends. The value of the classics is clear, and at least the English classics should be studied. The principal objects of engineering education are: first, to learn to think; second, to learn to express one's thoughts; third, to acquire a fundamental knowledge of general principles; fourth, the ability to find information in regard to the solution of any problem and put this into shape for the solution, and, fifth, to apply this general ability in a commercial way. Many other subjects would do fully as well as Latin or Greek. An elementary knowledge is very useful, but a knowledge of Spanish is of greater value to the American engineer than of any other language. Opportunities in Cuba, the Philippines and South America are constantly increasing, and a knowledge of Spanish often is the key to the situation. Scarcely one graduate in 10,000 has any real use for German. English and its literature are most essential.

Prof. G. F. Sever, of Columbia University, spoke of the differences in opinion as to the best methods among educators and briefly described the six-year optional course in engineering at Columbia, in which three years are devoted to elective collegiate studies and three years to engineering. No languages are studied in the engineering course. The University of Missouri now has a five-years engineering course. Professor Adams, of Harvard, emphasized the ability of the specialist to see into questions with less social bias than others.

At this point Mr. D. B. Rushmore took occasion to discuss the many-sided features of the Institute in its professional work and social intercourse. He spoke of the value of the work and experience of the presidents, and on behalf of the board of directors, while the audience rose, presented President Ferguson with an emblem signifying his becoming a past-president of the organization. President Ferguson replied in a happy vein, speaking of the unexpected situation in which he found himself, pointing out how the co-operation of the directors had dissipated his early anxieties as to the success of the administration and expressing his happiness in the work of the office during the year. He paid a glowing tribute to the faithful work of the different committees.

Mr. Dooley, in closing, said that there is a need for many different kinds of education and that children should be guided during their early years in the direction of their future work. President Ferguson offered an address delivered in December, 1908, by him at the Massachusetts Institute of Technology on "The Training of the Electrical Engineer," as a contribution to the discussion. Dr. Steinmetz said that in his paper he was striving to train the intelligent being to be a broad citizen of the Republic in the field of electrical engineering. The main point is to teach the boy how to live. Earning money is not the purpose of life, but a means to an end. The great fault of our nation and age is that we mistake the purposes of life and the means of living, which were better understood in former ages. Numerous factors contribute to a broader education. Pressure from within and without the engineering profession will provide the necessary method of broadening. The immediate step is to establish from two to three years of Latin and from two to three years of high-school Greek as an entrance requirement of the technical school and college. Classic languages should be received as an equivalent to modern languages in college entrance, taking any two out of Latin, Greek, Spanish, French or German.

CENTRAL STATION

MANAGEMENT, POLICIES AND COMMERCIAL METHODS

Street-Car Card Advertising Contest.

In order to obtain suggestions for street-car advertising the advertising committee of the Commonwealth Edison Company has established a prize contest for designs for a standard street-car card, 11 in. x 21 in., directing attention to the electrical service of the central-station company. Prizes of $15, $10 and $5 are offered for the three best suggestions submitted to the committee on advertising at 84 Market Street, Chicago, before Aug. 1. Only members of the Commonwealth Edison branch of the National Electric Light Association may engage in this competition.

Chicago Central-Station Department Directory.

The Commonwealth Edison Company of Chicago has long outgrown its headquarters in the Edison Building at 139 Adams Street. Various departments have been moved from time to time to another downtown building of the company known as the Electric Building at 84 Market Street. This is a large eight-story building with all but its two upper floors occupied by the central-station company, and these remaining floors will be used in another year. In addition to these two office buildings the company has space in other downtown buildings for various departments. There have been a number of changes this year, so that it may be useful to give the location of the various departments with the revised addresses. The subjoined list will also serve to give some idea of the varied activities of the company.

CENTRAL-STATION DEPARTMENT DIRECTORY.

	Address.
Advertising Department	84 Market Street.....Room 201
Arc Lamp Department	84 Market Street.....Room 305
Attorney	139 Adams Street.....Room 32
Auditing Department	139 Adams Street.....Fifth floor
Auditor	139 Adams Street.....Fifth floor
Cashier	139 Adams Street.....Room 1
Claim Department	139 Adams Street.....Room 21
Contract Department	139 Adams Street.....Second floor
General Contract Agent	139 Adams Street.....Room 22
Construction Department	84 Market Street.....Room 301
Superintendent of Construction	139 Adams Street.....Room 61
Customers' Repairs	72 Market Street,
Electric Shop	Michigan and Jackson Blvds.
Employment Bureau	139 Adams Street.....Room 57
Engineering Department	84 Market Street.....Room 602
Electrical Engineer	139 Adams Street.....Room 62
Engineer, Electrical Construction	84 Market Street.....Room 602
Engineer, Electrical Design	84 Market Street.....Room 602
Exhibition Room	139 Adams Street.....Second floor
Fuel Agent	139 Adams Street.....Fifth floor
Inspection Department	84 Market Street.....Room 601
General Inspector	84 Market Street.....Room 601
Lamp Renewals	82 Market Street.
Library	139 Adams Street.....Room 59
Load Dispatcher	139 Adams Street.....Room 65
Meter Department	84 Market Street.....Room 501
Superintendent Meter Department	84 Market Street.....Room 501
Operating Department	139 Adams Street.....Room 65
Chief Operating Engineer	139 Adams Street.....Room 65
Paymaster	139 Adams Street.....Fourth floor
President	139 Adams Street.....Room 53
Assistant to the President	139 Adams Street.....Room 53
Purchasing Department	139 Adams Street.....Sixth floor
Repair Shops	76 Market Street.
Salesman, General Merchandise	139 Adams Street.....Room 47
Sales Room	139 Adams Street.....Room 2
Second Vice-President	139 Adams Street.....Room 42
Asst. to the Second Vice-President	139 Adams Street.....Room 42
Secretary Advisory Committee	139 Adams Street.....Room 58
Secretary-Treasurer	139 Adams Street.....Room 32
Sign Department	84 Market Street.....Room 305
Statistical Bureau	1010 Home Insurance Bldg.
Stores Department	202 South Peoria Street.
General Storekeeper	202 South Peoria Street.
Street Department	84 Market Street.....Room 408
Superintendent Bldg. Construction	84 Market Street.....Room 602
Superintendent Edison Buildings	139 Adams Street.....Room 56
Superintendent Storage Batteries	139 Adams Street.....Room 65
Superintendent Substations	139 Adams Street.....Room 65
Testing Department	84 Market Street.
Transportation Department	South Morgan Street.
Treasury Department	139 Adams Street.....Fourth floor

Desirable and Undesirable Load.

At a meeting of the Wisconsin Electrical Association, at Waupaca, June 29, Mr. Ernest Gonzenbach, general manager of the Sheboygan Railway, Light & Power Company, gave a talk on desirable and undesirable railway and lighting business. As to the lighting business which is undesirable, he said that the idea of simply getting business had been too prevalent among the electric light men and that they had not sufficiently considered before going after a prospect what kind of a consumer he might be or whether he might better be left to the gas company. He said that he had yet to see the large store in the smaller cities that offered a profitable load. The power-station investment is likely to be in the neighborhood of $150 per kilowatt of capacity. The investment in lines and meters is from $75 to $100 per kilowatt of capacity. This makes the total investment per kilowatt from $200 to $250. On this the interest and depreciation will be at least $30 per year per kilowatt of capacity. If the store uses its maximum demand, 700 hours per year, a rate of 15 cents per kw-hour would just take care of interest and depreciation, leaving nothing for operating expenses. The lighting of factories which close at 5 or 6 o'clock every day is another class of very unprofitable business.

In discussion Mr. R. N. Kimball, of Kenosha, said that while some of this peak business might not be directly profitable, one must remember its advertising effect. If electric light is used in the large store it is likely to bring about its use in many other places.

Summer Selling of Electrical Appliances.

BY H. H. MCPHERSON.

The summer season was once considered to be the dull season in the sale of electric appliances. When the old-line gas companies began to feel the competition of the electric companies there were many who imagined that their days were numbered. But the wonderful increase in the use of gas for domestic and industrial fuel purposes, together with the rapid progress made in the use of gas for long-hour lighting have made the net returns from the gas business much larger than ever before. In much the same way the electric companies are building up their motor load and are creating a large domestic day load by selling large numbers of electric appliances, such as flatirons.

The summer selling of electric appliances is quite a different thing from selling of electric summer appliances. The summer season is the best time of the year for the selling of electric appliances for exactly the same reasons that almost everything sells better during the summer than during any other time of the year. In addition, the appliances add more to the comfort and convenience of the user during the summer months than they do at other seasons of the year. In recognition of the conditions which make the late spring and the summer months the most opportune time at which the sale of electric appliances can be pushed, most companies appropriate large amounts of money to the new-business and advertising departments to be used for this purpose.

The present article will not attempt to argue how this money can be spent to the best advantage, but will simply try to show how the soliciting end can be made to produce much better individual results by employing business methods from other similar business enterprises.

The selling of electric appliances is essentially a proposition of a large number of comparatively small sales which must be

made within a period of about four months. If this meant that the great majority of the buyers had to be educated and the sales closed in that length of time the task would be almost impossible. But such is not the case. While there may be a very large number of persons who can be properly called prospective customers because they do not have these appliances, the greater part of them can be classified by the first canvass, as far as the present season's work is concerned, into two classes—good and poor. The others may be called very poor, and, therefore eliminated from consideration. While it is perfectly true that every person is a prospective customer as long as he is without an appliance, and he should be visited periodically until the appliance is sold, whether it takes one month or three years, yet it may happen that a dead list of names is consuming a man's time while his real live prospective customers are waiting in vain to be called on.

With a good business house a careful campaign along any special line means, first, a list of prospective customers; second, a list of live prospective customers, and, third, and by no means least, an efficient follow-up system. The average representative for an electric company does the first very well, the second fairly well, and the third almost not at all. He usually makes his initial canvass with diligence and he places a note after each name showing whether he considers the possibility of sale good, poor or very poor, and also when he thinks another call should be made. That list and those notations are worth much in prospective to him and to his company, but in a memorandum book in successive order they are worth only cents instead of dollars, because it is almost impossible to follow them up.

Any average district in charge of a representative will yield, say, 2000 prospective electric-iron customers. How can any man expect to follow up a list like that, no matter what system he uses? Appliance sales are not usually made in one or two calls.

The lowest possible average number of calls per sale in an appliance season is five. The easy-going scientific salesman may make a better record than that. If he does one may rest assured that he has only hit the high places. The great body of good prospective customers whom several properly timed calls would have converted into buyers have probably never been called on even the second time. On the other hand, the salesman just mentioned will beyond a doubt make more sales than will the man who, in his desire to cover his list thoroughly, wastes the time on poor and very poor names that he should have spent on the good ones.

The hardest things in the business for an inexperienced man to overcome are the temptations which draw him away from his carefully thought-out plan. He allows the exceptions to swamp his rule. A typical case was that of a good grocery salesman who entered the electric new-business field with the selling idea uppermost in his mind. In his previous work he simply had to make rounds every so often, so his prospect work was almost nothing. On his new work he started in to make a complete canvass of his district. When he had covered about half of it he found that he had enough prospective customers to keep him busy, so he neglected the other half of the canvass. One month of the four was gone before his employer discovered that his early high sales record was due to the neglect of one-half of the district. The former grocery man was shown how to classify his prospective customers so that he could handle them and yet have time to complete his canvass. In this way his best energies were devoted to the best names, and the poorer ones were called on only when his first list had been properly followed up.

The form used for the prospect list follow-up depends on whether the man who uses it is to devote his whole time to the selling of appliances, or has additional work to do. In either case the list should be kept on cards in a "date-ahead" file, and there should be a separate card provided for each prospective customer.

A standard-size 3- x 5-in. card cut in half lengthwise makes a card which is sufficiently large to contain all needed information, and one of them can be put in each side of a standard-size vest-pocket card holder which has been sewed together lengthwise down the middle. On each card is put the date called on, name and address of prospective customer, name of the appliance which he may buy, date for next call, etc. If the card is plain each man can arrange this information as he sees fit. He would probably do so in any case. At night he simply drops each card in the file behind the guide card bearing the next call date. When he commences to make second calls he first picks out all the cards labeled "good." If he thinks he can call on more people than these good cards represent, he takes out enough of the poor cards to fill up his time, always being sure to select the most promising ones. After each call he checks each card properly and writes on a miscellaneous card any information in general which does not properly belong on the cards. At night he puts all of the cards taken out, whether the calls have been made or not, behind the date card for the next call or into the rear of the file if a sale has been made. He checks any information from the miscellaneous card onto the proper cards in the file, and then files these altered cards in their proper places for the next call. Then he takes out the next day's cards, and so on.

There are many honest differences of opinion regarding such a plan as this. It was once said by some famous man, "Always remember that the other fellow's idea is a scheme; yours is a plan." This particular plan is designed to cure a specific trouble which is common to all men who keep an up-to-date list of prospective customers. Many systems could be made more elaborate than this one, but the writer knows of none more concise and practical. The special fault with most other systems is that they require too much time and labor in keeping them up to date. If the necessary time is not spent such a system soon becomes a useless maze of red tape.

The cards for the above system have been chosen from standard-size material because such material can easily be obtained. They have been made small because a larger size is not needed and enough of them can, therefore, be carried so that each memorandum is written directly upon the card to be filed and not copied from some other pad. The "date-ahead" system is used because all that is necessary each night is to file the cards by next call dates and to pull out the next day's cards. Even the filing can be neglected for a few days if time is lacking. Moreover, the date-ahead system keeps important facts ever before one. The information is never lost or buried, and it is easy to sort delayed matter into the days ahead. A glance at the pile of cards behind each date card will tell how heavy a day's work lies ahead, and the cards in the rear of the file are a never-failing spur to the sales record.

A word should be said about other systems. The old memorandum book means no flexibility, dead lists and an improper "follow-up." The "date-ahead" book is somewhat better, but the spaces for each day are uniform in size, which means too much room in some spaces and too little in others. The card system with indexes by names or streets and date tabs means more time used in keeping it up to date because it is necessary to put a date tab on each card, find the name index card and put it in and then having to go through the reverse process to take it out.

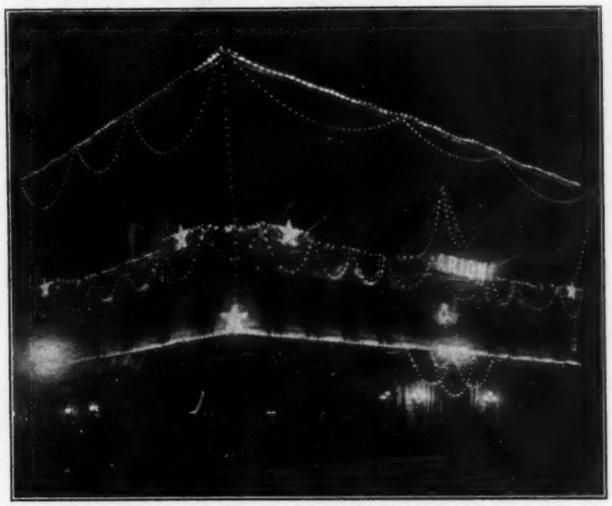
In addition, it does not show at a glance the amount of work ahead nor the sales made. The card-index system of cards for each kind of appliance means no flexibility, a constantly growing mass of dead timber, and it is really little better than the old-style memorandum book. If date-ahead tabs are added to it, it becomes the equal of the date-ahead book.

With some such system as has been described it is possible to keep an almost perfect "follow-up" in an up-to-date condition with only five or ten minutes work per night. The sales value of such a system has been shown conclusively by the sales record of the man who first used it. Working on nothing but old prospective customers he doubled the sales record of the previous year, which included new houses as well as old.

INTERIOR WIRING AND ILLUMINATION

Decorative Lighting at the Arion Club, New York City.

During the recent convention of singing societies held at Madison Square Garden, New York City, the Arion Society, one of the largest German singing organizations in the city, was the principal host of the visiting singers. Appropriate to the occasion, the Arion Society had the exterior as well as the interior of its large and commodious clubhouse at the southeast corner of Park Avenue and Fifty-ninth Street profusely decorated with electric lights. The accompanying illustration gives a view of the outside illumination by night. The system of exterior lighting here shown is that including the use of stranded duplex Elblight cable containing 4-cp electric lights attached by pin-socket contacts. The star design and the lettering shown in the picture were outlined by standard 4-cp screw-base and socket lamps. In the illumination 4000 all-frosted 4-cp carbon lamps were used, giving a most striking effect. The current supply for the decorative lighting was from the alternating-current mains of the United Electric Light & Power Company, New York City.



DECORATIVE LIGHTING AT THE ARION CLUB, NEW YORK CITY.

Some Faults in Conduit Wiring.

BY THOMAS NORTON.

Assuming that well-insulated wire is employed, the function of metal conduit is evidently to provide the necessary channels for wires to be drawn through a building and to protect them throughout their entire length when in position from mechanical, chemical or electrolytic damage. Iron and steel, of course, offer the best mechanical protection; but being affected themselves by acid, alkalies, water and moist air, they must be protected from damage also. From an electrical viewpoint, nothing meets the requirements of wiring practice so satisfactorily, nor is there any material possessing equal or better protective qualities for the same cost as iron pipe.

When installing conduit continuity of the system and proper earth connections are necessary. On this point the underwriters mark that it is essential that the metal of conduit systems be joined so as to afford electrical conductivity sufficient to allow the largest fuse or circuit-breaker in the circuit to operate before a dangerous rise in temperature in the conduit system can occur. Conduits and gas pipes must be securely fastened in metal outlet boxes so as to secure good electrical connection. Where boxes used for centers of distribution do not afford good electrical connection, the conduits must be joined around them by suitable bond wires. Where sections of metal conduit are installed without being fastened to the metal structure of the buildings or grounded metal piping, they must be bonded together and joined to a permanent and efficient ground connection. It is recommended that cables, outlet boxes and fittings have conductive coatings in order to insure better electrical contact at all points throughout the conduit system, and if the conduit, couplings, outlet boxes or fittings have protective coatings of non-conducting material such as enamel, such coating must be removed from threads of both couplings and conduit and from surfaces of boxes and fittings where the conduit is secured in order to obtain the requisite good connection. It is well to note that fires have occurred through leakages from conduit to soft metal gas pipes, and while continuity and grounding are admittedly necessary as a protection against danger to persons they are by no means an absolute safeguard against fire risk. A ground wire of small sectional area was formerly considered all that was necessary to minimize the risk to persons from shock or burn; but it was soon found that a fault on a main protected by a fuse large enough, would result in dangerous overheating of a small ground wire, so that ground wires should have ample cross-section. It is best, if possible, to have two independent grounds to every installation and to protect the ground wire by conduit or molding.

A point that should receive consideration in conduit work, especially in concrete buildings and in refrigerating rooms, is the draining of the conduit. In all conduit work condensation is bound to occur because of temperature changes, and if pockets are formed in the conduit where water will gravitate, condensation breakdowns are liable to result. Undoubtedly a wire of good quality properly vulcanized with outside braiding treated with a good weather-resisting compound and showing a good insulation test after 24 hours' immersion in water, cannot be harmed much through the existence of condensation in the conduit. But if a wire has been injured when being pulled through the conduit, kinks formed in it, tools dropped on it or persons with heavy shoes permitted to walk on it for any length of time, a breakdown can be looked for at such spots where injury might have occurred before installation. Water may also creep along the wire and cause trouble at ceiling outlets, switches, etc. This latter defect can be remedied by the employment of suitable compound or rubber tape near the contact. If all connections have been sweated bitumen can be poured in the junction boxes where excessive condensation exists with good results. The outlets of junction boxes on vertical runs can be drained by an outlet at the bottom of the tube or a T employed instead of a bend. If free circulation of air is prevented condensation troubles may be reduced to a minimum.

To increase the durability of the pipe, it is common to use a black Japan varnish with a paraffin base or with a linseed oil base. Galvanizing is also very generally employed. In grounding such pipes good contact should be obtained and the ground connection should be made in such a way that the ground can be removed easily and periodic tests made to see that clearance from foreign grounds exists. It is rarely that a dead short occurs on a good grounded pipe system, the defects being generally connected with faulty switch wires and lamps. If contractors and wiremen use care in manipulating conduit and fittings so as not to knock off the enamel or other coating unnecessarily, the conduit will not deteriorate rapidly. It is possible, for instance, where conduits are cut into joists and boarded over to drive a nail through the conduit if it is thin, and where the conduit has been subjected to hard usage and the coating scraped off, it deteriorates and rusts so that it can be easily penetrated by a nail at any time. Where the conduit is galvanized, the coating cannot be so easily removed and the metal is better protected from the action of the air and moisture.

Electrical Effects at the Wright Brothers Celebration at Dayton, Ohio.

On June 17 and 18 the city of Dayton celebrated the home-coming of the Wright brothers, the distinguished aviators. The streets were especially decorated for the occasion and the work,

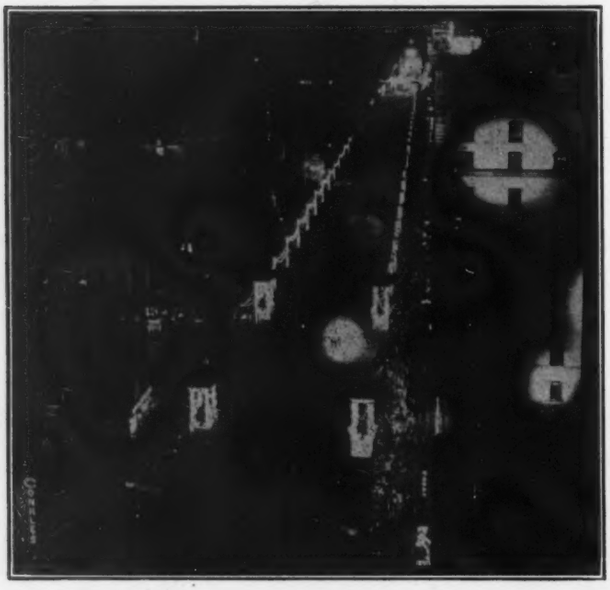


FIG. 1.—NIGHT VIEW OF COURT OF HONOR FROM TOP OF BUILDING.

done by the Dayton Lighting Company, made the display more attractive by night than by day. The accompanying illustrations show Main Street by day and night. There were 30,000

FIG. 2.—NIGHT VIEW OF COURT OF HONOR.

4-cp lamps installed. The formal demonstration lasted two days, but the company carried the display two days longer for the benefit of the town people. The court of honor on the

FIG. 3.—PARK ILLUMINATION, "BUNCH OF GRAPES" EFFECT.

main street was very attractive at night, as shown by Figs. 1 and 2, Fig. 1 being taken from a high building. Fig. 3 was taken in one of the parks, showing the result obtained with 4000 16-cp lamps, so hung as to produce the effect of huge bunches of grapes. Celluloid cases in various colors, about 8 in. in diameter, were loaned by the National Cash Register Company to cover the lamps. The effect is very inadequately shown by the reproductions of the photographs. Those competent to judge pronounced it one of the finest pieces of decorative illumination ever accomplished. Besides the bunches of grapes in the trees, there were vertical strings and streamers of lamps. This tree decoration occupied about one full city square.

The court of honor is shown by day in Fig. 4. It was installed by the committee on arrangements, but the Dayton Lighting Company planned the lighting effects throughout. Besides the street and park decoration, four searchlights were located on the tops of four of the most prominent buildings and were

FIG. 4.—DAY VIEW OF COURT OF HONOR.

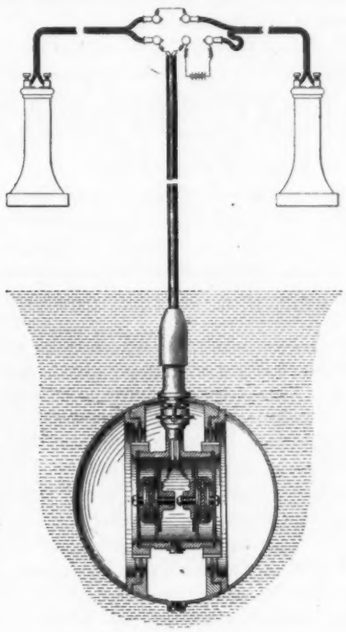
operated so that they attracted attention all over the surrounding country. This temporary installation is a good example of the vigorous way in which the Dayton Lighting Company, under the management of Mr. F. M. Tait, secretary-elect of the National Electric Light Association, takes hold of public enterprises in its city.

New Telephone Patents.

TRANSMITTERS.

For audiphone uses the telephone transmitter must be adapted to pick up sounds from certain directions, rather to the exclusion of those from other directions. For this purpose a transmitter is usually of rather a different type from that for ordinary telephone working. With a view to increasing the efficiency of such a transmitter Mr. O. L. Falk, of Belleville, N. J., has patented a concentrator for mounting on the face of the transmitter. This comprises a conical tube of sheet metal, the outer, or wide end, of which is extended all around into a convex flange, having such a curvature that its edges lie in the plane of the small end of the tube. This device is of sheet metal and is arranged to be mounted in front of the transmitter with the small end of the tube confronting the center of the diaphragm. It is so placed that there is left a narrow slit all around between the outer edges of the convex flange and the transmitter face. When the transmitter is directed toward the source of sound this is received in two ways. First, through the conical tube, and, second, reflection from the face of the transmitter and through the narrow slit, and thence from the rear side of the convex flange to the diaphragm. The inventor's idea is to sufficiently exclude disturbing sounds not coming from the desired direction, so adjusting screws are provided by means of which the width of the slit between the transmitter face and the flange may be reduced at will. Mr. Falk has assigned his patent to the American Telephone & Telegraph Company.

For receiving submarine signals by means of the telephone it is essential that a water-tight receptacle be provided for the transmitting elements which are to pick up the sounds traveling through the water and transmit them to receivers located on shipboard. Mr. A. J. Mundy, of Boston, Mass., has patented such a receptacle and assigned his patent to the Marion Signal Company. The receptacle is spherical in shape, the sphere being divided into three compartments by two parallel



MUNDY SUBMARINE TELEPHONE.

cross-partitions. Both the partitions are perforated with a large central perforation, which is closed by the diaphragm of the two transmitters. The microphone buttons occupy the middle compartment lying between these two diaphragms. The remaining compartments, with their spherical sides, act as concentrators to receive vibrations from the water and focus them upon the diaphragms. This arrangement is shown herewith.

COMBINED ALARM AND TELEPHONE SYSTEM.

Mr. E. E. Salisbury, of Chicago, Ill., has obtained a patent for a combined telephone and signaling system, his apparatus providing for both still alarms and general alarms. The alarms are, of course, sent in by means of step-by-step signal devices after the general nature of a messenger-call apparatus. The devices are so interlocked that the telephone will never interfere with the alarm signal and when a general alarm is being sent in no secret one can be started in a manner to interfere with it. This patent is assigned to the Signalphone Alarm Company.

NEW SUBSCRIBER STATION APPARATUS.

With private lines worked on the common-battery system, wherein the battery supply is at some point between stations, it has always been somewhat of a problem to enable the stations to signal each other because of the shunting effect of the battery-supply tap on the ringing current. Several schemes have been suggested by the use of slow-acting relays, etc., but all are more or less complicated. Mr. F. S. Davenport, of Atlanta, Ga., now suggests the use of the condenser discharge for this purpose. To this end, he provides at each station a rotary circuit-breaking device, which normally comes to rest in the open-circuit position, but which upon rotation will produce a series of momentary short-circuits in the line. Accompanying each short-circuit, the condensers at all stations discharge through their bells, in series with them, and, with the following opening of the short, the condensers become recharged through the bells. This rapid charging and discharging of the condenser result in an alternating-current flow in the magneto bells, which will result in operating them to produce the calling signals.

Recently there has been a considerable movement in favor of the use of two ear pieces at subscriber stations. One of the schemes put upon the market is an auxiliary earcap, attached to the receiver earcap by means of a rubber sound-conducting tube. Another scheme is the provision of an auxiliary receiver of the watchcase type, the cords of which are connected in multiple to the cord terminals of the main receiver. Mr. W. H. Taylor, of Stanford, Conn., has obtained a patent for the combination with a supporting hook, of such an auxiliary receiver connected in parallel with the main receiver, its cords being attached to the main receiver terminals.

A sound shield forms the subject of a patent granted to Mr. M. P. Flack, of New York City. This comprises a conical appliance, adapted to be clamped upon the face of a transmitter by means of the regular mouthpiece. The small end is just the size of the lip of the mouthpiece, while the large end is of a size sufficient to take the nose and mouth of the telephone user. The edge of the cone is faced with a pneumatic cushion, which will form a soft rest for the face and which will sufficiently follow the contour of the face to prevent the escape of speech. Small vents are left in the walls of the cone to permit of easy breathing, but these are not of sufficient bore to permit the escape of sound.

MISCELLANEOUS APPARATUS.

The plug socket of a switchboard has in the past been used in a number of different ways to cause the operation of switches to effect special changes required in the circuits. Mr. C. D. Enochs, of La Crosse, Wis., has now planned to use the socket to restore clearing-out drops. To this end he mounts his clearing-out drop in the face of the switchboard, immediately above the keyboard, while by means of a linkage associated with the plug socket, causes the shutter of the drop to be restored when the plug reaches the seat. Mr. Enochs has assigned his patent to the Vote-Berger Company.

A call-registering system forms the subject of a patent granted to Mr. J. H. Meyer, of Magdeburg, Germany. The call-registering apparatus is located at the central office and is responsive to special keys associated with the various cord circuits and in position to be manipulated by the operator. An auxiliary relay is so associated with each cord circuit that it is possible to register but once for each connection.

LETTER TO THE EDITORS.

Spark Ignition.

To the Editors of Electrical World:

SIRS:—Referring to the article by Prof. F. W. Springer in your issue of June 24, together with your editorial upon the same, some experiments that I have been fortunate enough to be able to conduct with the endeavor to seek the proper character of spark for igniting the gases in an internal combustion engine may be of interest.

The engine was equipped with a coil of abundant power, and means were provided to control its output. The engine card was continually under observation by means of a manograph which traced the card in the form of a spot of light on a ground glass screen. The experiments were started with a spark just feeble enough to jump the points and ignite the mixture. The strength of the spark was gradually increased, the manograph being closely observed as this was done. The engine, it may be added, was kept at constant load and was controlled by a throttling governor.

With a light spark it was noticed that the explosion line of the card was considerably inclined toward the toe. As the strength of the spark was increased the explosion line straightened up and became practically at right angles with the intake line. The initial pressure was reduced, the mean effective pressure, of course, remaining the same. The energy of the primary circuit was measured and found to be about six watts.

The efficiency of transformation of the coil was unknown because of the lack of adequate instruments to measure the secondary output.

It was believed that there was no virtue in increasing the spark beyond the point where the explosion line became vertical, for this of course gave for all practical purposes instantaneous ignition of the mixture.

From this it would appear that there is a decided difference in the performance of an engine when ignited by sparks of different calorific power. This has been observed practically by many when switching the ignition system from a starting battery to a dynamo or magneto, or switching the ignition system from a weak battery to a strong one. As was very correctly stated in the editorial, the battery economy is becoming less and less of a factor. In the opinion of the writer, the spark provided should be such as to make the explosion line vertical under the worst possible condition of mixture that may be obtained, and beyond that every effort should be concentrated on making the ignition apparatus thoroughly reliable, the difference of economy with so small an amount of power as 6 or 8 watts being distinctly secondary.

New York. George T. Hanchett.

DIGEST OF CURRENT ELECTRICAL LITERATURE

Abstracts of the important articles appearing in the electrical periodical press of the world

Generators, Motors and Transformers.

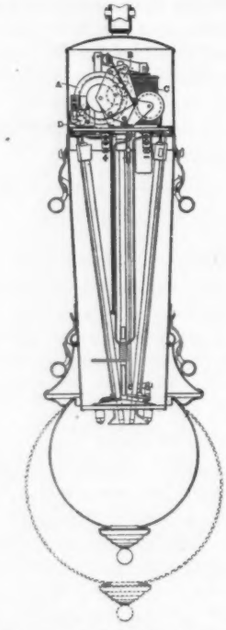
Dynamo Brushes.—J. Liska.—An abstract of a thesis on the friction of dynamo brushes. The author investigated the friction coefficient as a function of the pressure, speed, temperature, current density, direction of current, etc. Twelve different dynamo brushes were tested. The friction coefficient was determined as the ratio of the force of friction to the pressure. Concerning its dependence on the pressure at constant temperature and speed, when current is zero, it is found that an increase of the pressure (from 0.06 kg to 0.5 kg per square cubic meter) increases the friction coefficient; but generally much more slowly than the pressure, although it is different in some special cases. The friction coefficient was then investigated as a function of the peripheral speed (between 2 m and 25 m per second) at constant pressure and temperature. For most brushes it is independent of the speed and decreases very little with increased speed, although two exceptions were found. The friction coefficient was then determined as a function of the temperature between 15 deg. C. and 100 deg. C., with constant pressure and speed. For most brushes the friction coefficient is constant, in a few it increases slowly, in others the decrease reaches 50 per cent. The effect of a change of current density (between 0 amp and 15 amp per square centimeter) was then determined. For most brushes the friction coefficient is smaller if the current passes from the brushes to the ring, then in the opposite direction. For alternating current the friction coefficient has about the mean value. The deviations amount generally to 15 per cent or 20 per cent. The Morganite brush is exceptional in several of the above respects. Finally the material and the condition of the contact surfaces are investigated. On a dry copper commutator the friction coefficient is in the average 20 per cent to 50 per cent smaller than on the bronze ring. Lubrication with oil or fat increases the friction; lubrication with kerosene decreases the friction coefficient by about 50 per cent. The absolute value of the friction coefficient varies with graphite brushes between 0.06 and 0.2; with carbon brushes between 0.06 and 0.35; with metallic graphite brushes between 0.05 and 0.3, and with metallic brushes between 0.1 and 0.5.—*Elek. Zeit.*, June 17.

Series Transformers.—M. Seidner.—An article giving the theory of series transformers used in compounding methods and booster transformers. The author first investigates the case of constant secondary resistance and then the case of variable secondary resistance with constant-phase difference: the case of constant secondary impedance with varying phase difference; the case in which the secondary impedance varies inversely as the primary current; the case in which the secondary resistance brakes the current variations. The article is illustrated by diagrams.—*Elek. und Masch.* (Vienna), June 6.

Induction-Motor Diagram.—W. Rogowski.—An article illustrated by diagrams giving a simple derivation of the Heyland and Ossana circular diagrams of the induction motor.—*Elek. und Masch.* (Vienna), May 30.

Lamps and Lighting.

Flame-Arc Lamp.—An illustrated description of the new "Flamgold," double-carbon, gravity-feed, flame-arc lamp. The two pairs of carbons are burnt alternately, the arc changing over every 15 to 20 minutes. Interesting features of the lamp are the bell-shaped brass economizer, and the magnets for the control of the arc. A 9-amp, direct-current lamp burns for 20 hours on one trimming, and an alternating-current lamp for 18 hours. Although there are two pairs of carbons, there is only one clockwork mechanism, and no change-over device is needed, the carbons being fed down simultaneously. The action is as follows: The two pairs of carbons are connected in parallel, and on switching in the lamp, the arc is struck between one pair. The series solenoid then immediately draws out the arc to its proper length by means of a rod attached to a sliding plate or collar surrounding the negative carbons and carried on rollers. As the carbons are consumed, the clockwork is released by a detent on the regulating lever, and the carbons are allowed to feed. This feeding goes on for from 15 to 20 minutes, during which time the pair of carbons not in use gradually approach one another and finally touch, causing the arc to strike across the other pair. The arc is, however, instantaneously drawn between the second pair of carbons and



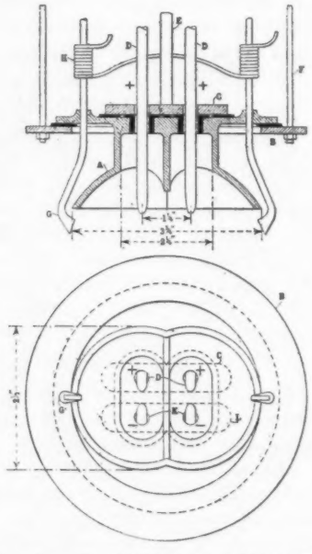


FIG. 1.—MECHANISM OF LAMP. FIG. 2.—DIAGRAM OF ECONOMIZER SHOWING CONTROLLING MAGNETS.

extinguished on the other pair by the action of the series solenoid which separates the carbons in consequence of the increase of current. Feeding of both pairs of carbons then takes place until the first pair again comes in contact and causes the arc to strike across the second pair. A general view of the mechanism of the lamp is given in Fig. 1. The carbons are suspended from an insulated drum *A* by means of woven copper

cords, the usual beaded flexible connections being dispensed with. The copper cord supporting the positive pair of carbons is passed twice round and fixed to one-half of the drum, while the cord for the negative carbons is fixed to the other half. Two revolutions of the drum correspond to the full feed of the carbons, and to obviate the necessity for rubbing contacts a coiled copper strip in each half of the drum is fixed at one extremity to the drum, and at the other to a fixed terminal, and thus gives an unbroken circuit from lamp terminals to carbon holders. The clockwork train ends in a brake wheel *B* to which is attached a fan blade, and is released when the detent *C* on the regulating lever lifts the brake from the wheel under the influence of the shunt coil. The economizer, together with the blow-out arrangement, is shown in Fig. 2. The economizer itself is a bell-shaped casting *A* divided into two halves by a partition. Insulating bushings are provided where the positive carbons pass through the roof, and mica insulation is provided between the economizer and the positive guide plate *C* and the frame plate *B* respectively. The sliding plate or collar *L* runs on little metal wheels on the top of the economizer to ensure smooth regulation and evenness of burning. The blow-out magnets are also shown in the same illustration.—Lond. *Elec. Eng'ing,* June 17.

Auto-Transformers for Metallic-Filament Lamps.—J. L. CATEAUX.—A note on some details which have to be observed in the use of auto-transformers for low-voltage metallic-filament lamps. Owing to the supply pressure being usually slightly higher than the declared voltage, especially at times of light load, it has become fairly common practice to use 105-volt lamps on 110-volt circuits, and 210-volt lamps on 200-volt circuits, but a similar precaution is just as necessary for low-voltage lamps with auto-transformers. The transformer should therefore, in most cases, be wound for a supply voltage 5 per cent above the normal, unless in some few cases it is known that the supply is never above the normal. The regulation itself also has an important bearing on this point, and in properly designed apparatus it should not exceed 4 per cent to 6 per cent over-all (the higher figure in the smallest sizes only). It is a common error to suppose that 2 volts or 3 volts overrunning will not matter; it is entirely a question of percentage, and 2 volts extra on 25 has just the same effect upon the lamps as 8 volts extra on 100. Even if trouble is not experienced by the blackening of the bulbs, the life of the lamps must necessarily be materially shorter than if they burned at their correct voltage. A point which is often overlooked in low-voltage installations is the advisability of using a certain percentage of carbon-filament lamps in places where light is only required intermittently and for short periods.—Lond. *Elec. Review,* June 18.

Efficiency of Lamps.—In a report presented by the German Government to the German Congress on the occasion of the recent proposed, but rejected, tax of electricity and gas, the following figures were given: For the efficiency of electric lamps the hefner cp-hours per kw-hour are: Ordinary incandescent lamps, 330; improved incandescent lamps, 500; Nernst lamps and tantalum lamps, 500; osram, tungsten, and zirconium lamps, 700 to 1000; alternating-current arc lamps, 800; direct-current arc lamps, 1000; flame-arc lamps, 2000; mercury-vapor lamps, 1600; quartz tube, mercury-vapor lamps, 3000. For gas lamps the cp-hours per cubic meter of gas are: Welsbach incandescent gas lamps, 560; inverse gas lamps, 1030; and compressed-gas lamps, 1000.—*La Revue Elec.,* June 15.

Tungsten Lamp.—A note on a recent British patent of W. D. Coolidge (17,621, 1908; June 10, 1909). Fine tungsten powder reduced from tungsten trioxide is mixed with a binding agent, consisting of 42 per cent cadmium, 53 per cent mercury, and 5 per cent bismuth. The product, containing from 30 to 40 per cent of tungsten, is squirted into rods which are drawn into filaments, or is squirted into filaments directly. These are baked in an open furnace for from 15 to 45 minutes, and then fired in a furnace until all except the tungsten is evaporated and the latter sintered to the required degree. For this last treatment the filaments are placed in graphite boats and raised to a temperature of about 1800 deg. C. in the presence of hydrogen.—Lond. *Elec. Eng'ing,* June 17.

Reducing Carbon in Metallic-Filament Lamps.—A note on a recent British patent of the Wolfram Lampen A. G. (10,891, 1908; June 10, 1909). The filaments are brought to a red heat by the passage of a current in an atmosphere of hydrogen and sulphuretted hydrogen. The latter is decomposed, the sulphur combining with the carbon in the filament, while the free hydrogen reduces any metallic sulphide that may be formed. The gases should be at a greatly reduced pressure, and free from air and moisture.—Lond. *Elec. Eng'ing,* June 17.

Metallic-Filament Lamps.—A note on a recent British patent of A. Kroll and B. Saklatwalla (27,144, 1908; June 10, 1909). In squirting the filaments a double die composed of two dies placed coaxially is used. The outer die is fed with collodion gelatinized in alcohol-ether and the inner die with the metallic paste. Colloidal tungstic acid may be used as the collodion coating is impervious to water, and prevents the filament loosing its water and getting inflexible before the sintering treatment. The outer die protrudes over the orifice of the inner one, and the metallic core can be compressed by adjusting the pressure of supply, and a fine filament produced without using a fine die. —Lond. *Elec. Eng'ing,* June 17.

Power.

Gas-Power.—CHARLES E. LUCKE.—A paper on the value of gas-power. It is particularly valuable on account of a number of numerical tables for estimating energy costs for plants up to 250 hp. Besides giving values for the cost of energy they show all the elements entering into it, together with their relative importance. The total cost of energy per hp-hour increases with the cost of coal per ton, but by no means in direct proportion; thus, for 75 hp an increase of five times in the coal cost changes the total energy as follows: Total energy cost between 1½ times for half time, full load as a maximum, and 1⅛ times for quarter time, full load as a minimum. This shows the importance of coal cost by itself. The effect on operating cost is not very different, as this is increased at the same time between 1¾ times to 1⅞ times, a little more, which is explained by the relation of operating and fixed charges. The same limits will apply to total cost for the larger engines, so that the cost of coal per ton has no relation to the size of the engines so far as its effect on this total cost is concerned; but by reason of the difference in the ratio of operating to fixed charges the effect on operating cost will be different, lying between 1½ and 2½ times, as the cost increases 5 times the cost of coal per ton. The effect of increased size of engine is marked in its reduction of total energy costs chiefly because the fixed charges are smaller per unit for the large ones. A similar reduction of operating cost is likewise the effect of increased size, because oil and labor costs do not vary in proportion with size. Coal costs per hp-hour are dependent only on cost per ton and on the individual load. The strongest factor in every case in fixing energy costs is the load factor, especially where low load factor is the result of low individual engine load.—*School of Mines Quarterly,* April.

Power Plant of Turbine Factory.—O. LASCHE.—Since the turbine factory of the Allgemeine Elektricitäts-Gesellschaft in Berlin was to be enlarged it was decided to erect a special power plant. This is equipped with two turbo-dynamos each rated at 2000 kva. The turbines are of the Curtis type. The steam consumption is 5.35 kg (11.8 lb.) per kw-hour, including excitation and excluding condensation, with 98 per cent vacuum.—*Zeit. d. Ver. Deutscher Ing.,* April 21 and May 1; abstracted in *Elek. und Masch.* (Vienna), June 6.

Air Compressors.—J. HAVLICEK.—Two papers on electrically-driven air compressors. In the first paper the author discusses the variations of the power. He finds that the driving motor should have as high a flywheel effect as is possible with good design. The "coefficient of lack of uniformity of revolution" (Ungleichförmigkeitsgrad) should be 1/100. The motor must have at least 3 per cent slip. In specially difficult cases a slip resistance must be inserted in the rotor circuit to raise the slip to 5 per cent or 6 per cent. The period of the variations of

power must differ from the period of the generators of the power plant. In the second paper, the author deals with the regulation of electrically-driven air compressors, discussing three different methods of regulation.—*Zeit. d. Ver. Deutscher Ing.*, April 10; abstracted in *Elek. und Masch.* (Vienna), June 6.

Steam Turbine.—C. von Groddeck.—An illustrated paper read before the German Association of Electrical Engineers emphasizing the importance of close co-operation between mechanical engineers and electrical engineers in designing and testing turbo-generators. The adaptability of the steam turbine to varying conditions, its use in various industries, and its influence on the design of dynamos were discussed.—*Elek. Zeit.*, June 17.

Lack of Water in Boilers.—M. Geiger.—Lack of water in most cases up to 90 per cent is the cause of boiler explosions. It also causes other troubles. The author discusses the different arrangements which safeguard the presence of sufficient amount of water in boilers.—*Zeit. d. Bayer. Revis. Ver.*, Jan. 31 and Feb. 15; abstracted in *Elek. und Masch.* (Vienna), June 6.

Turbine Regulators.—A. Budau.—An article illustrated by diagrams describing a number of different electric turbine regulators.—*Elek. und Masch.* (Vienna), June 6.

Traction.

Tramway Statistics of England.—The first of the annual tables containing the statistics relating to electric tramways, railways, and power companies of the United Kingdom. The statistics comprise 119 electric tramways, 16 electric railways and 19 power companies. The existing trade depression is strongly felt. The number of tramway undertakings at work has hardly changed, and important extensions of existing tramways are few. As for the power companies, "those that are working are not too prosperous, while those that have not yet succeeded in making a start seem no nearer doing so."—Lond. *Elec. Review*, June 18.

Catenary Suspension.—P. Dawson.—A continuation of his long serial on electric traction on railways. The author gives theoretical considerations of catenary suspension with formulas and curves.—Lond. *Electrician*, June 18.

Installations, Systems and Appliances.

Automatic Switch for Transformers.—A description of an automatic switch devised by L. T. Stone for switching out the primary of a transformer when the load on the secondary falls below a predetermined value. Fig. 3 shows the connection of the switch to an auto-transformer. One terminal of the alternating supply is connected to a coil *A*, the other terminal of which is joined to the lamp *a* and switch *b*, whence a connection runs to the intermediate terminal b_1 of the auto-transformer *B*. The same supply terminal is also connected through a main switch *D* to one terminal b_2 of the auto-transformer. The auxiliary switch *C* is actuated by the coil *A*, and is diagrammatically shown as of the mercury cup type. A second coil *E* in series with switch *C* is connected to the other terminal b_3 of

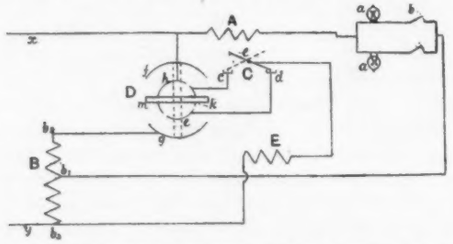


FIG. 3.—CONNECTIONS OF SWITCH WITH AUTO-TRANSFORMER.

the auto-transformer, and to the other supply terminal *y*. The coil *E* actuates the main switch *D*, connecting the lamps across the transformer. Switch *D* consists of six sections, of which *f* is connected to *x* and to *h* (two sections joined together); *g* is connected to the end b_2 of the auto-transformer; *k* to one contact *c* of the switch *C* and *l* to the other contact *d*. The switch arm *e* is joined to the coil *E* and the contact arm *m* makes the required connections between the contacts of switch *D*. The contact arm is operated by a catch on the armature of coil *E*, which engages in turn four pins suitably placed on the switch, moving the arm through an angle of 90 deg. each time *E* is energized. In operation, when one of the switches *b* is closed to light a lamp, current flows from *x* through *A*, the lamp *a* and switch *b*, to the point b_1 of the auto-transformer, and so to

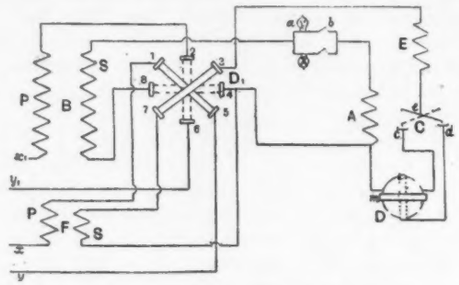


FIG. 4.—CONNECTIONS IN SUBSTATION.

y through a part of the transformer, which acts as an impedance in series with the lamp, so that the current passing is very small. The coil *A* being energized, its armature moves and operates the switch *C*, making contact at *c*; when this happens, current will flow from *x* to *h*, through the arm *m* to *k*, through the auxiliary switch *C* and through *E* to *y*. The armature of *E* moves the contact arm *m* into the dotted position, making the circuit from *x* through *m* to *g* and through the transformer to *y*. The lamp circuit is from *x* through *A* to the lamp and switch, and so to the intermediate terminal b_1 of the transformer, the normal mode of connection. The circuit through *E*, it will be seen, is broken. The contact arm *m* now rests on *l*, in connection with contact *d* of switch *C*. When the lamp *a* is switched off, *C* acts and coil *E* is again energized, moving the switch arm through 90 deg., and thus leaving the switch *D* in its original condition. In Fig. 4 an arrangement is shown, for use in a substation, to cut a transformer out of circuit at times of light load. The action in this case is similar to that above described, but a separate small transformer *F* is used, connected to a separate source of supply. The secondary of *F* is connected to the load through the switch D_1; when a lamp is switched on, coil *A* actuates switch *C*, and this causes coil *E* to actuate switches *D* and D_1, connecting the main transformer *B* to the load and cutting out *F*. The latter may be replaced by low-pressure supply from another substation.—Lond. *Elec. Review*, June 18.

Earthing the Neutral Point of Three-Phase Generators.—G. W. Worrall.—A communication on the practice of Swiss and Italian generating stations with respect to the earthing of the neutral points of three-phase generators. In general the neutral is insulated; in one case, however, considerable disturbances have been experienced and the neutral has been earthed with beneficial results. In another case the neutral has been insulated but permanently connected to one side of an ordinary horn arrester mounted on top of each machine, the other side of the arrester being connected directly to earth. The gap was so adjusted that a spark would pass when the neutral rose above 6000 volts to earth. The tension of the system was 11,000 volts between the lines. Each line was, in addition, protected by lightning arresters in the usual way. It is stated that the apparatus worked well and the generators were in no way disturbed when the neutral flashed over to earth.—Lond. *Electrician*, June 18.

Wires, Wiring and Conduits.

Insulation for Cables.—A note on a recent British patent of E. S. Ali Cohen, P. A. Cramer and W. Geipel (10,535, 1908; June 10, 1909). Paper tape is passed through a bath of paraffin and then coated with a bituminous composition comprising about 63 per cent of purified asphalt, 18.4 per cent of solidified petroleum, and 18.6 per cent of liquid paraffin. The treated paper is wound spirally over the cable, alternately with layers of a similarly impregnated textile tape. An alternative method con-

sists of rendering the bituminous composition elastic, and rolling and cutting the product into tape, without the addition of paper. Such a cable can be vulcanized afterward if sulphur has been added to the composition. To avoid decentralization, layers of textile tape may be wound between the layers.—Lond. *Elec. Eng'ing*, June 17.

Electrophysics and Magnetism.

Electrons and Valency.—J. M. NELSON AND K. G. FALK.—A paper on the electron conception of valency in organic chemistry. The authors make an attempt to extend J. J. Thomson's views of the linking of atoms with each other by the transfer for a corpuscle to the compounds of organic chemistry, and a number of cases occurring with these compounds are explained in this way. The cases involving geometrical isomerism are considered principally and possible explanations are given without considering special relations at all, by the addition to the ordinary conception of the bond between two atoms the idea that this bond possesses a definite direction.—*School of Mines Quarterly*, April.

Units, Measurements and Instruments.

Ballistic Test for Inductance.—G. KAPP.—Fig. 5 shows a known method for the determination of the inductance of a coil by ballistic galvanometer. The battery B supplies current to the

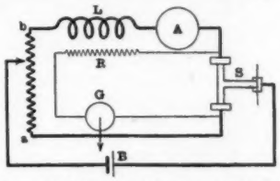
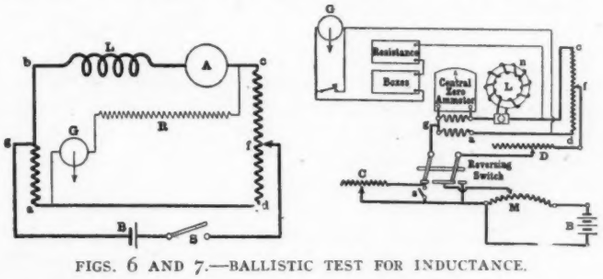


FIG. 5.—BALLISTIC TEST FOR INDUCTANCE.

coil L to be tested, an ammeter A, and a resistance $a\,b$, with sliding contact, which is so adjusted that the galvanometer G shows no deflection as long as the switch S remains closed. R is a high resistance put into the galvanometer circuit in the usual way. On opening the switch the battery becomes detached and the coil discharges through the galvanometer, the deflection of which is a measure for the flux in L that has vanished when the battery circuit was opened. This method is perfect in theory, but very difficult to carry out in practice. It can only give accurate results if the switch S breaks both its contacts absolutely at the same moment. In order to avoid an expensive and specially constructed switch, the author has devised the arrangement shown in Fig. 6, and found it to work quite satisfactorily. It has the advantage that no special apparatus is required, the switch S being of the usual type. Also in this case a sliding contact f is used to supply current to the two halves of the circuit, one-half containing the coil to be tested and an ammeter A. The sliding contact is so set that the galvanometer with S closed shows no deflection. In this case the points a and c have the same potential and the whole system forms a Wheatstone bridge in balance, the arms being



FIGS. 6 AND 7.—BALLISTIC TEST FOR INDUCTANCE.

$a\,g$, $g\,c$, $c\,f$, and $f\,d$. If, now, S be opened the coil L discharges through two parallel circuits—namely, $R\,G$ and $c\,d$—and the galvanometer shows a deflection which is a measure of the flux that has disappeared in L. By a suitable choice of the various resistances, it is possible to obtain the same deflection as with the first method. The second method may be applied with advantage to the determination of the hysteresis loop of laminated iron samples made up in ring form. Fig. 7 shows the arrangement of the test in this case. The author finds it convenient to employ a Siemens milliammeter and to use its own shunt and a spare shunt ga to make up the resistance of the branch $agbLAc$. M is a main current regulator supplied from a battery and D is a rheostat for fine adjustment of the maximum value of the exciting current for each setting of M. It is also useful in making sure that the time constant of the circuit is kept sufficiently low for the particular galvanometer used. C is another rheostat for taking intermediate points of the loop. The resistances of M, D and C need not be known. The resistances of cd and of the circuit agc need only be known approximately to make the correction in R. For taking the H-B relation the switch s remains closed, but for taking the complete hystresis loop, C and s must be worked in the well-known manner. The galvanometer is provided with a damping key as usual. The measurement includes the inductance of the ammeter, and, to eliminate that, a plug is attached to the coil so that it may be short-circuited and the inductance of the ammeter be determined separately.—Lond, *Electrician*, June 18.

Standards of Magnetic Field Intensities.—R. GANS AND P. GMELIN.—In the exact determination of the field intensity of magnetic fields, considerable, and often unexpected, difficulties are encountered. Nevertheless, if all sources of error are considered, a very high accuracy can be obtained. Gans has, therefore, designed standards of magnetic field intensity in order to facilitate the quantative study of physical phenomena in the magnetic field. These standards were made by a firm of instrument makers in Munich, and calibrated by Gans. The calibration showed that with the aid of these standards magnetic field intensities between 3000 and 7300 gauss can be exactly reproduced at any time. In order to get an idea of the accuracy of the standards, Gans and Gmelin have now designed a "fundamental standard," which they have tested and calibrated by two different methods. This fundamental standard is suitable for currents between 0.8 amp and 1.5 amp, and gives very homogenous field intensities between 5000 gauss and 9000 gauss. It was found that the magnetic field intensity can be determined with the accuracy of 0.2 per cent.—*Ann. der Phys.*, No. 5; abstracted in *Elek. und Masch.* (Vienna), May 20.

Measuring Feeble Currents.—R. ARNO.—An illustrated paper describing an apparatus for the measurement of telephone currents and in general all periodic currents of high frequency and very small intensity. The principle is as follows: Two rotary magnetic fields of the same intensity and frequency, but revolving in opposite directions, act each on one or two little hollow steel cylinders mounted on the same axis of rotation and representing the movable part of the apparatus. One of these two cylinders can be subjected at the same time to the action of a second magnetic field produced by the telephone current to be measured which passes through a special coil surrounding this cylinder. In this case the hysteresis of the cylinder changes and deflection are obtained. The theory and construction of the apparatus are described in detail.—*Bull. de la Soc. Internat. des Elec.*, April; *La Revue Elec.*, June 15.

Radiation Pyrometer.—E. LAUGHLET.—In the former radiation pyrometers of Fery, which measure the total radiation, the radiation is concentrated on a thermo-couple. This thermo-couple has now been replaced by a spiral made of three different metallic strips so as to unroll when heated, acting directly on the needle. The instrument is strong, self-contained and inexpensive, although not quite as exact as the pyrometer with the thermo-couple. In the same issue a thermoelectric calorimeter of Fery is described.—*La Revue Elec.*, June 15.

Meters.—R. KENNEDY.—An article sketching the evolution of mercury motor direct-current electricity meters, making some suggestions as to improvements. The master patents for this class of instruments have all expired in England.—Lond. *Elec. Review*, June 18.

Telegraphy, Telephony and Signals.

Telefunken System.—COUNT ARCO.—The conclusion of his long illustrated paper read before the German Association of

Electrical Engineers on the new system of the Telefunken Company. The principles of the system were described last week in the Digest. It is claimed that it combines the advantages of the spark method and of the arc method without their disadvantages. It has a high efficiency and is almost indifferent to atmospheric and other disturbances.—*Elek. Zeit.*, June 10 and 17.

Telefunken System.—Count Arco.—An illustrated translation in abstract of his recent German paper.—Lond. *Electrician*, June 18.

Lepel System.—von Lepel.—A reply to the article by Count Arco. The author insists that "the new Telefunken system is not an accidental, but an intentional copy of my system," and gives many data on the development of his system, which has been mentioned before in the Digest.—Lond. *Electrician*, June 18.

Lepel System.—J. Erskine-Murray.—A preliminary account of experiments with the Lepel wireless-telegraph system. The author comes to the conclusion that "the Lepel generator acts on the principle of impulsive excitation (Stosserregung) enunciated by Professor Wien; that the damping of the primary circuit is sufficient to attain this result, which is obtained by proper proportioning of the electrical dimensions of the circuit without the insertion of the additional energy-wasting resistance used by the Telefunken Company for this purpose, and that the use of a direct-current supply is in no way incompatible with the efficient production of a high-frequency current by this method."—Lond. *Electrician*, June 18.

German Association of Electrical Engineers.—A report of the proceedings of its recent annual convention, held at Cologne. A committee was appointed to consider higher education for the men who erect machines, install lamps, etc.; also a committee on practical training of students. Th. Koehn reviewed in a paper the large new European hydro-electric plants and their commercial importance. G. von Groddeck discussed the use of large steam turbines in electric stations. E. Rosenberg gave new details of construction of direct-current and alternating-current turbo-generators of the British Westinghouse Company. E. Ziehl discussed the construction of direct-current turbo-dynamos and showed the superiority of completely compensated machines over those equipped only with interpoles. C. Krämer described a new machine of the Felten & Guilleaume-Lahmeyerwerke A. G.; when supplied with constant current it changes the voltage automatically according to the external resistance. It is of normal construction and especially suitable for hoisting, for rolling mills, for charging batteries, for welding installations, etc. K. Fischer described a machine for making condensers by means of a specially prepared paper (pertinax). The new "universal lamp" of the Regina Arc Lamp Company, which operates without regulating mechanism, was exhibited. Bermbach described details of the Conta lamp. A. Libesny gave a review of the development of metallic-filament lamps during the last year. He finds that under present conditions lamps consuming less than 1 watt per candle-power are not economical enough, even with high prices for current, to compete successfully with 1-watt-per-cp lamps. Count Arco described the new wireless telegraph system of the Telefunken Company.—*Elek. Zeit.*, June 17.

BOOK REVIEWS.

Grundgesetze der Allgemeinen Elektrizitätslehre. By Fritz Hoppe. Leipzig: Johann Ambrosius Barth. 114 pages, 118 ills. Price, 4 marks.

This volume, one of a series of electrotechnical publications, is of a very practical nature and forms an elementary text-book for students of electrical engineering. A large number of electric and magnetic principles are discussed in a brief and simple manner. The purpose in view is manifestly to introduce the student to the underlying principles of electrical engineering. The book will be valued by students of electrical engineering in this country who are acquainted with the German language.

Die Uhr, Grundlagen und Technik. By H. Bock. Leipzig: B. G. Teubner. 136 pages, 46 ills. Price, 1 mark, 25.

This is an elementary historical and technical little text-book on the subject of clocks, watches, chronometers and timekeepers generally. The treatment is descriptive with a little arithmetic and elementary algebra. It is suitable for the technical student, not specializing in horology, and for the educated members of the public generally. The style is clear and interesting. We should like to see an English translation produced.

Handbuch fur den Bau und die Instandhaltung der Oberleitungsanlagen Elektrischer Bahnen. By Arthur Ertel. Hannover: Dr. Max Janecke. 336 pages, 294 ills. Price, 4 marks, 20.

A very practical and complete handbook for the use and reference of constructing engineers engaged in electric street-railway work. The illustrations are numerous and excellently chosen. The work is restricted to direct-current railroad systems. Within these limits the book is the best on its own subject that we have yet seen in the German language.

Die Theorie der Besselschen Funktionen. By Paul Schafheitlin. Leipzig: B. G. Teubner. 129 pages. Price, 2 marks, 80.

A mathematical text-book on Bessel functions from the German standpoint. Certain inquiries in physics, notably in heat-conduction, sound, and electricity, lead to a particular differential equation which Bessel, a German astronomer, first solved. The functions which solve the equation are usually expressed in the form of infinite series, and are known as Bessel functions. The book is a useful compendium of the more elementary part of the subject discussed, which possesses an extensive literature. It will be valuable to students of mathematics as a German text-book.

Kraft. By. Prof. Dr. E. Reyer. Leipzig: Wilhelm Engelmann. 380 pages, 248 ills.

The author presents in this volume a comparative analysis of natural and acquired resources among the principal civilized nations. The historical development of the various industries receives much attention. The iron and steel industry receives especially full treatment. In general, the countries that are most frequently brought into comparison are England, Germany and the United States. The output of coal, steel and textiles, the importation of foods and the development of power are studied from an economical standpoint in great detail. The curves and diagrams are numerous, but are very poorly executed from the standpoint of the engraver and illustrator. The book will be of interest to the student of international economics.

La Technique de la Houille Blanche. By E. Pacoret. Paris: Dunod & Pinat. 830 pages, 10 plates, 290 ills. Price, 25 francs.

In the domain of engineering, from the snowfall on the mountains to the delivery of hydro-electric power to consumers, there is a wide and diversified field occupied by the hydraulic engineer, the mechanical engineer and the electrical engineer. The subject in its full extent is ordinarily treated separately in books on water-power and dams, books on turbines, and books on electric transmission and distribution. This book, however, endeavors to include the entire field within its covers. It is divided into two main parts, the first dealing with water, water-power, hydraulic measurements, turbines and hydraulic installations. The second part deals with the electric installation. The work has been written by an engineer as an engineering text-book. It is abundantly illustrated with pictures, diagrams and data from actual hydro-electric plants. The book is clearly written and forms an excellent treatise on hydro-electric engineering as practised in the mountainous regions of France, Switzerland and Italy.

NEW APPARATUS AND APPLIANCES

Car Lighting with Opalux.

The introduction of tungsten lamps has given a decided impetus to car lighting and with this has come a demand for new types of reflectors. One of the most serious practical drawbacks to efficient car lighting with reflectors is the inevitable collection of dust or dirt, and, as is well known, the efficiency of the average type of reflectors is seriously impaired by this unavoidable accumulation. With the ordinary type of reflector it is absolutely essential that the lamps be removed, and the reflectors subjected to a thorough washing in order to remove the dust or dirt. This necessitates constant attention, and is frequently costly, in that aside from the actual expense of time and wages of the caretakers, an additional and very heavy expense is introduced due to the breakage of reflectors and tungsten lamps incident to the necessary handling. Realizing the disadvantages under which car lighting is being conducted, the Central Electric Company, of Chicago, Ill., has been experimenting with its "Opalux" reflector, and the results so far are reported as very gratifying. The accompanying illustration shows a dining-car completely equipped with "Opalux" bowl-type reflectors, and experience so far indicates that this new type of reflector will prove a very efficient aid in the proper illumination of railway cars.

CAR LIGHTING WITH OPALUX.

Aside from high efficiency, "Opalux" reflectors have a highly artistic appearance, the reflected light being of a pearly luster, and slightly opalescent. The transmitted light shows a variation of soft-colored tints, and illuminates the ceiling with a warm glow, entirely free from sharp contrasts in intensity. The ornamental detail has been designed to present no sharp corners or deep groves, but an even surface very readily cleaned.

Cut-Outs for Arc-Lighting Service.

The accompanying illustrations show cut-outs designed for both series and multiple arc-lighting circuits in which convenience and safety of lamp trimmers have been well considered. The old style of cut-out made use of a switch for breaking the circuit, whereas the improved form is automatic in action, the lamp being disconnected from the line by simply pulling the supporting rope.

Fig. 1 shows the series cut-out as connected in service. The circuit is closed by means of spring contacts, and a locking device holds the lamp in position. This device is contrived to release the lamp when it is lifted slightly from its normal position. It can then be lowered to the ground, as shown in Fig. 2, and the necessary repairs can be made without the slightest danger to the lineman.

A cut-out of similar design is available for use on multiple arc-lighting circuits. Both the series and multiple cut-outs are manufactured by the General Electric Company, Schenectady, N. Y.

FIGS. 1 AND 2.—ARC-LIGHT CUT-OUT.

Alba Glass.

With the progress of illuminating engineering the work of the makers of electrical glassware becomes of increasing interest and importance. Considerable attention has been attracted of late by a new semi-translucent glass invented by the Macbeth-Evans Glass Company, of Pittsburgh, and known as "Alba." This is a white glass which lights up most attractively (it has been likened to a lace curtain, but it is a greater protection to the eye than this comparison would imply), and it is said to cause a loss of less light than any other glass with a cased or white coat inside. Further, it does not have the effect, like some white glassware, of making the filament of an incandescent lamp, for instance, appear red when viewed through it.

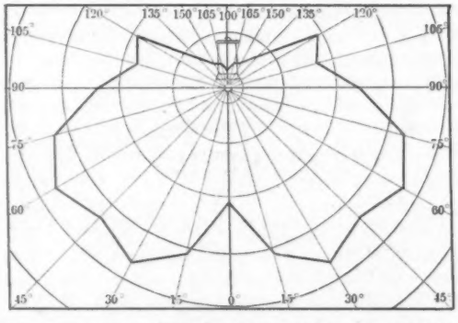


FIG. 1.—LIGHT DISTRIBUTION OF ALBA GLASS GLOBE.

Alba glass is the result of researches to produce a satis-

factory "obscured" or semi-opaque glass for outer or inner globes for arc lamps; but it is also used as a shade for incandescent lamps with excellent effect. One good feature is the fine diffusion of the light. The Macbeth-Evans Company

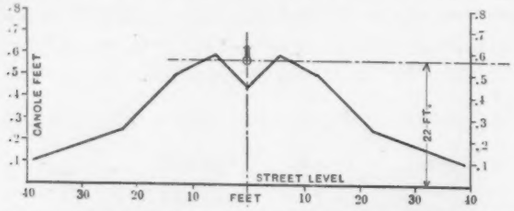


FIG. 2.—HORIZONTAL DISTRIBUTION CURVE FOR ALBA GLASS GLOBE.

thinks that the best combination ever put on an arc light is an Alba outer globe and a "Thermo" clear inner globe, the latter a glass of extremely high melting point and small expansion and contraction.

The accompanying curves of illuminating efficiency of Alba

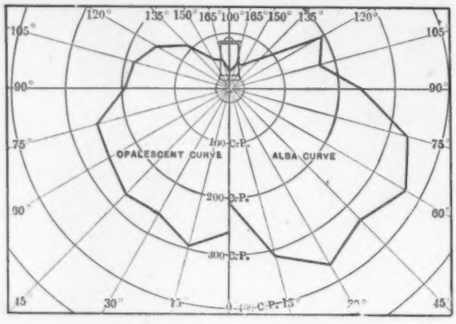


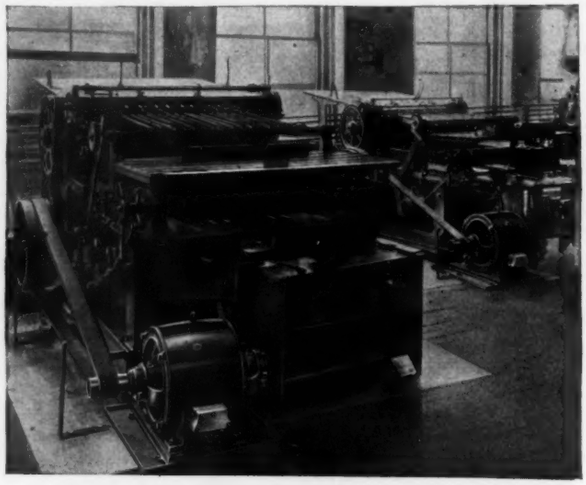
FIG. 3.—LIGHT DISTRIBUTION FROM OPALESCENT AND ALBA GLASS GLOBES.

glass were made, according to the manufacturer, by Prof. H. S. Hower, of the photometric laboratory of the Carnegie Institue of Technology. Owing to the variation in candle-power in some directions caused by the shifting of the arc, the curves were determined by from 20 to 80 observations with the same lamp, and the general average taken.

Electric Motors in Printing Establishments.

After 22 years' experience in the printing industry and, therefore, 22 years' experience with steam power, line shafting and belt transmission, the mercantile printing establishment located at 157 William Street, New York City, and operated by Gazley Brothers, has all its machinery driven by electric motors. Altogether they have installed nine motors, varying in horsepower from 1½ hp to 3½ hp. Eight of these motors drive separate machines, while the other motors drive a line shaft from which are operated several small job presses. The cut shows two of these motors, each of 3½ hp, operating two Whitlock cylinder presses. The motors which are installed at this plant are a direct-current, compound-wound type for printing-press use manufactured by the Western Electric Company. Variable speed is obtained by field control, the controller being provided with about 15 forward speeds and several back speeds. The controllers are especially designed for printing-press service and equipped with no-voltage release, overload release and arrangement for push-button stop.

The conditions incident to the former steam drive in the above-mentioned establishment were no worse than in others which have used line shafting for an equal length of time, but they were bad enough: Dust and dirt from sweeping and cleaning collected from time to time on the ceiling and shafting and was being continually fanned down by the fingers which receive the work from the cylinders of the Whitlock presses. Whenever this dirt was swept down a certain amount of it would get into the machines and type cases, thus causing much annoyance, often at times when least welcome. Since the motors have been installed and the line shafting practically all removed, the pressroom has been repainted and the work is now being carried on in a clean and sanitary atmosphere. The clean



MOTOR-DRIVEN CYLINDER PRESSES.

white walls, the absence of belting from floor to ceiling and the slapping and flapping of belts in this room make it a striking contrast to its previous condition.

"Exide" Meeting at Dayton, Ohio.

The Dayton Lighting Company extended invitations to an illustrated lecture given under the auspices of the Electric Storage Battery Company, of Philadelphia, on Tuesday, June 22, in the auditorium of the Y. M. C. A. Building, Dayton, Ohio. The meeting was opened by Mr. F. M. Tait, general manager of the Dayton Lighting Company. He spoke of the popularity of the electric vehicle in Cleveland, Buffalo, Chicago and other cities and stated that the object of the meeting was to arouse public interest in this type of vehicle which Dayton, up to this time, had neglected. Mr. H. M. Beck, engineer of the operating department of the Electric Storage Battery Company, delivered the principal address, touching briefly on the history and development of the "Exide" battery and covering very fully and clearly all points regarding the operation of these batteries. The address, illustrated with lantern slides, was greatly appreciated by an audience of about 100, a number of whom took part in the discussion which followed the reading of Mr. Beck's paper. The meeting aroused considerable interest in the electric vehicle and gave a clearer understanding of the subject to the electrical engineers, garage men and vehicle owners who were present than they had hitherto possessed.

Westinghouse Electric Mine Installations.

Among recent installations of electrical machinery by the Westinghouse Electric & Manufacturing Company in the mining territory of several States are the following: Washoe Smelter, of the Anaconda Copper Mining Company, at Anaconda, Mont., four 600-hp motors driving Root blowers and two additional 600-hp slow-speed motors driving high-pressure air compressors for pneumatic-locomotive service. Helena Power Transmission Company, Butte, Mont., a Westinghouse turbine plant, which supplies the local Butte mines in parallel with a 70,000-volt, 85-mile transmission line. Leonard Mine, of the Boston & Montana C. C. & S. M. Company, two 300-hp pairs of 150-hp motors, each direct-connected to Nordberg pumps, and a similar 150-hp motor driving an Aldrich pump. Modoc Mine, of the Anaconda Copper Mining Company, Butte, Mont., a semi-automatic relay-controlled hoist.

Industrial and Commercial News

Commercial Intelligence.

THE WEEK IN TRADE.

Reports of trade conditions for the past week show still further expansion, and the demand for fall and winter goods is larger than it has been at any time within the past two months. Retailers report that business is improving, and the general situation in trade is much more satisfactory. This is largely attributable to the better weather and the better condition of the crops in the Northwest. In the South the improvement of business has been, to some extent, checked by the unfavorable condition of the cotton crop; but, as the price of the staple has rapidly advanced on the Government's crop report, the planters will probably be as well provided with money as if they had raised a larger crop and sold it at cheaper rates. There have been good reports from the many clearance sales throughout the country, and retailers' stocks are being steadily reduced. In industrial lines the gains which have been recorded for the past three months continue to be in evidence, and especially in the iron and steel manufactures the reports are encouraging. Building is as active as heretofore, and the reports from the lumber trade show that it is picking up and feeling the effect of the general awakening. In the textile industries good bookings are being reported for fall deliveries, and the mills are being operated at practically full capacity. Failures have been fewer and liabilities smaller during the past six months than for the same period in 1908, but are larger than in any previous six months for the past 10 years. According to *Bradstreet's* reports, there were 6,149 failures in the first half of 1909, a decrease of 18.6 per cent from the previous year. Liabilities aggregated $880,561,976, a decrease of 55 per cent from the previous year. Failures for the week ended July 1 were 213 against 223 for the previous week; 236 in the same week in 1908, 135 in 1907, 134 in 1906, and 127 in 1905.

THE COPPER MARKET.

Developments in the copper market during the past week were few and unimportant. Trading has been exceedingly dull and for the last few days preceding the holidays reached a condition of absolute stagnation. The general disposition to make no commitments over the holidays was as evident in the metal market as in those which are more active. There is a disinclination on the part of domestic consumers to buy at prevailing prices, due undoubtedly to the popular belief that better bargains can be made later on and to the fact that stocks are now being carried by many manufacturers considerably in excess of immediate needs. The statistical position, both here and abroad, is adverse to higher prices. While the official figures of the Copper Producers' Association will undoubtedly show a decrease in the stocks of marketable copper carried by the producers, the fact will remain obvious that there is more copper unmelted in this country and Europe than ever known before. Production of the domestic mines has been going on at high pressure record, imports have been phenomenally large and consumption has been only moderate. The fact that the ever-growing surplus has largely changed hands, from producers to middle men and consumers, does not make it any the less a surplus. Exports of copper during June amounted to 33,399 tons, the heaviest monthly record since December, 1907. But this copper does not go to the melting pot. Since the first of May stocks in the warehouses of Great Britain have increased 38,000,000 lb. and those on the Continent have been proportionately swelled. In addition to the record breaking production, imports during June were exceptionally heavy. Arrivals at all points are estimated at more than 15,000 tons. Official prices are practically unchanged. On the Metal Exchange July 3 quotations were as given in the table.

Lake	13¼ @ 13⅜
Electrolytic	13 @ 13⅛
Casting	12¾ @ 13

The London prices July 2 were as follows:

	Noon. £ s d	Close. £ s d
Standard copper, spot	58 17 6	58 17 6
Standard copper, futures	59 10 0	59 15 0
Market	Quiet.	Steady.
Sales of spot		600 tons
Sales of futures		1,000 tons

Extreme fluctuations for this year:

	Highest.	Lowest.
Standard	.....	.....
Lake	14.55	12.55
Electrolytic	14.25	12.12½
Casting	14.12½	12.00
London, spot	£64 2 6	£54 12 6
London, futures	64 17 6	55 10 0
London, best selected	67 15 0	59 0 0

RECENT ORDERS TAKEN BY CROCKER-WHEELER COMPANY.—The Crocker-Wheeler Company has recently received several orders for large alternating current generators. One of these, from De Laval Steam Turbine Company, Trenton, N. J., called for one 1000-kw, 3-phase, 6600-volt turbo-generator. A sale made to the Smith Gas Power Company, Lexington, Ohio, called for one 400-kw, 3-phase, 240-volt alternator, to be used for power and lighting. The A. C. Cheney Piano Action Company, Castleton-on-Hudson, N. Y., placed an order for a 330-kw, 3-phase, 60-cycle generator. Another order was received from the Iowa Dairy Separator Company, Waterloo, Iowa, for one 200-kw, 3-phase engine-type alternator. Among the large orders for direct generators recently booked by this company is one from George A. Fuller Company, Chicago, calling for three 250-volt machines with a total capacity of 500 kw. Many other orders have also been received for smaller equipments, including generators and factory motors, aggregating 1200 kw of the former, and 572 hp of the latter.

PROGRESS OF LIGHTING IN EUROPEAN CITIES.—H. M. Hirschberg, president of the Excello Arc Lamp Company, has recently returned from a trip to Europe, in which he combined business and pleasure. Mr. Hirschberg says that the use of flaming arcs for street lighting is growing very rapidly in European cities, especially in Germany. As he visits Europe at this season every year he has had an opportunity to observe the progress of this development. He says also that the use of tungsten lamps is becoming general for all interior lighting, and that on some of the railroads in Germany small tungsten lamps have been installed. One of the new things which Mr. Hirschberg saw abroad was a new gas lamp, known as the Keith lamp, which is used in some of the German cities for street lighting. This lamp used an inverted mantle, and the gas is mechanically delivered under high pressure. He says that the light is very bright, and that the lamp is recommended as being economical.

OPENING OF THE HUDSON TUNNELS.—Invitations have been issued for the first train to carry passengers through the Hudson & Manhattan Railroad tunnels under the North River, between Cortlandt Street and Jersey City. This train will leave the Manhattan side at 10 o'clock in the morning, July 19. Traffic between Manhattan and Jersey City will be regularly installed in the afternoon of the same day. The builders of the steel cars deny that the delay in opening the tunnel service is due to tardiness on their part. The engineers now say that the delay is due to the fact that the makers of electrical fittings are weeks behind the time set for shipping supplies. This is confirmed by the larger manufacturers of electrical apparatus, who say that most all of the smaller corporations making these fittings were unprepared for the sudden increase in business, and are from one to three months behind their orders.

GROWTH OF NEW YORK TELEPHONE BUSINESS.—The new directory of the New York Telephone and New York & New Jersey Telephone companies will contain the names of about 310,000 subscribers. It is estimated that the edition will amount to 500,000 copies, and will require 1500 tons of paper. The services of 350 men will be needed for its distribution. These figures indicate, to some extent, the growth of the telephone business in the City of New York.

NAVY ELECTRICAL SUPPLIES.—The Bureau of Supplies and Accounts, United States Navy Department, has issued a schedule of miscellaneous electrical supplies and minor apparatus for which bids will be opened July 20.

THREE-PHASE ELECTRIC TRACTION IN THE CASCADE TUNNEL.—Dr. Cary T. Hutchinson left on July 4 for Leavenworth, Wash., to conduct the final train tests of the electrification of the Cascade Mountain tunnel on the Great Northern Railroad. The work of electrification in the tunnels is practically complete, and the power houses will probably be ready for operation by the middle or latter part of this month. While no date has yet been fixed for putting the full electrical service into operation in the tunnels, it is expected that this will be done before the end of August. The present electrification is over a stretch of road about six miles long, including the yards and switches at the ends of the Cascade tunnel, which is almost three miles long. Already several work trains have been operated in the tunnel by means of electric locomotives, but regular service will not be undertaken until the power stations are entirely complete. The hydro-electric plant is expected to develop 6000 kw, of which 4000 kw will be required for pulling one train through the tunnel. If the present installation proves entirely successful, the entire Cascade Mountain division of the Great Northern, which is about 60 miles long, will be electrified. Four additional locomotives have recently been added to the equipment, and it is expected that the entire traffic of that section will eventually be handled by electricity. The locomotives are of the double-truck type, 45 ft. long, the rigid wheel base being only 11 ft., so that they can take curves without difficulty. The weight of each is 115 tons, and the driving wheels are 5 ft. in diameter. The motors are wound for 500 volts, but as the transmission lines are operated at 6600 volts each locomotive is supplied with transformers. These locomotives are of the three-phase type, and the engineers in charge believe that they will operate at constant speed regardless of the grades and loads.

INCREASED DEMAND FOR MOTOR CARS.—Alfred Reeves, general manager of the American Motor Car Manufacturers' Association, has recently returned from a trip to New England and the Middle West, where he has been making a careful collection of figures from the makers of axles, magnetos, frames and other automobile parts. Mr. Reeves says that there is sure to be an increase of 125 per cent in the production of automobiles in the year 1910 over the production of 1909, which is placed at 75,000 cars, and which it is now apparent will be insufficient to supply the demand. He says that 200,000 cars are planned for next year. Of these, 165,000 will be pleasure cars, and 30,000 will be high wheel buggies made by carriage concerns. He estimates that 5000 will be electric carriages and commercial vehicles. Mr. Reeves says that the average price for this large output of automobiles will be between $1,200 and $1,500, as it has been demonstrated that the heaviest demand is for this class of machine. He says that the demand for automobiles has increased so rapidly that the manufacturers are entirely unable to keep up with their orders.

NEW SOUTH CAROLINA POWER PLANT.—Duncan & Lyndon, engineers, at 56 Pine Street, New York, have recently made a report upon a new hydro-electric plant which is projected in South Carolina. The site for the plant is on the Saluda River, about 10 miles from Columbia, S. C., and it is estimated that a plant of about 12,000-kw power can be constructed. The principal market for this energy will be among the cotton mills, which are numerous in that section, although some of it will probably be sold to traction and lighting companies. The same interests that are identified with the project are in control of the Augusta & Aiken Railway Company, which is projecting an extension to Columbia. The same engineers have also made a report upon a small proposition at Clifton, a village near Springfield, Ohio, which is designed to furnish 200 kw. In this connection, there is a new traction line contemplated, to be known as the Springfield, Wilmington & Cincinnati Railroad.

TO BUILD NEW STATION AT JOPLIN, MO.—H. L. Doherty & Company, who recently took over several properties near Joplin, Mo., have organized a new company for the control of these interests, as has been stated in a previous issue. This new company, which has not yet been named, will absorb the Consolidated Light, Power & Ice Company and the Zinc Fields Power & Light Company, together with some interests in other companies. It is now proposed to build a new station six miles west of Joplin, on the Kansas side of the State line. This will be located on Spring River, but will be a steam plant, and will have installed at the start two 5000-kw turbo-generators.

CUBAN INFORMATION BUREAU.—The Secretary of Agriculture, Commerce and Labor of the Republic of Cuba announces that a bureau of information has been established in connection with his department where any person wishing data concerning Cuba, her resources, business opportunities, agricultural and industrial advantages can be accommodated. President Gomez has appointed Leon J. Canova, an American newspaper man, who has resided in Cuba 11 years and has a wide acquaintance with the Island, as director of the bureau. Anyone desiring information should address, Utility and Information Bureau, Department of Agriculture, Commerce and Labor, Havana.

LARGE ISOLATED PLANT FOR CHICAGO.—A large new building is to be built for the department store of Rothschild & Company, Chicago, on State Street, extending from Van Buren to Jackson Street on the east side of the street, replacing the present building. The architects, who are Holabird & Roche, of Chicago, are now working on plans for this structure. This firm will also have charge of the engineering for the building. An isolated plant will probably be installed to produce electric light and power, and the lighting installation of the building will probably include 25,000 or 30,000 incandescent lamps.

STANDARD UNDERGROUND CABLE COMPANY.—The directors of the Standard Underground Cable Company met June 26 in Pittsburgh and elected Joseph W. Marsh, president and general manager, to succeed the late M. W. Watson. Mr. Marsh had previously been vice-president and general manager. W. A. Marsh, general superintendent, was elected first vice-president, and P. W. H. Smith, general manager of sales, was elected second vice-president. F. A. Rinehart, secretary and treasurer of the company, was made a director.

WESTINGHOUSE TURBINES FOR LIGHTING PENNSYLVANIA TUNNELS.—The Pennsylvania Tunnel & Terminal Company, operating the Pennsylvania Railroad tunnels under New York City and the rivers, is installing in its Long Island City power house two 2500-kw Westinghouse turbine-alternator sets for lighting the tunnels and terminals. The reliability required in this service has demanded that every precaution be taken to insure absolute continuity of operation of the generating and distributing systems. The alternators will supply three-phase, 60-cycle current at 440 volts.

COMMONWEALTH EDISON PROFIT SHARING.—The Commonwealth Edison Company, of Chicago, has inaugurated a profit-sharing plan for its employees, whereby an investment can be made of from 3 to 5 per cent of their salaries, to be compounded at 6 per cent semi-annually. At the end of five years the employee is given an option of investing in the company's stock at par. It is expected that the majority of the 2,500 employees will avail themselves of the plan.

ELECTRIC ADVERTISING SIGNS.—A firm of electric-light engineers and contractors in the British Isles has applied to an American consular officer there with the object of securing an agency for the sale of electric-advertising signs. Further information may be obtained from the Bureau of Manufactures, Washington. The file number of the inquiry is 3584.

ELECTRIFICATION OF NEW YORK CENTRAL.—In the expense budget of the New York Central & Hudson River Railroad for the current year, which amounts to $21,488,755, the sum of $8,477,682 is set aside for electrification of the suburban lines and the New York terminals.

ELECTRIFICATION IN THE NORTHWEST.—Robert E. Strahorn, president of the North Coast Railway Company, which is building a line from Spokane, Wash., to the Pacific Coast and Puget Sound, announces that the line will be electrified in the division that crosses the Cascade Mountains.

Financial Intelligence.

THE WEEK IN WALL STREET.

In violation of the almost universal rule, the stock market was not entirely lifeless during the short week that preceded the triple holiday. While the trading was not great, there was much more than had been anticipated. It may be said, however, that the public participated very little in the business. The smaller grade of professional traders were the people in evidence. The tone of the market was strong and general advances were recorded. It was an easy matter for the regulars, as there was an entire absence of selling pressure. The pro-

fessional dealers liquidated a month ago when stocks were at the top. This selling caused a reaction of from 5 to 10 points and when prices were at the lowest they began to load up again. It is not at all likely that another selling movement will begin until prices have again gone to new high levels. In this condition there are more buyers than sellers, which generally means a slow market with advancing prices. In the meantime there are no influences at work to check the upward trend of the market. Industrial and commercial improvement continues; the crop situation—with the exception of cotton—is all that could be desired; the reports of the railroads show vastly improved earnings and the money market remains as easy as ever in spite of the heavy demands made upon the banks to meet the July interest and dividend payments. In addition to these payments there was withdrawn during the week $5,000,000 of gold for export, but the price of money was unaffected. It is a market that advances if let alone and which it requires heavy pounding to depress. Money was quoted on July 2: call 1¾ @ 1⅞, 90-day 2¼ @ 2½ per cent. The quotations in the table are those of the close July 2.

NEW YORK.

	June 28.	July 2.	Shares Sold.		June 28.	July 2.	Shares Sold.
All.-Ch.	15⅛*	15⅛	700	Int.-Met., pfd..	52	49¼	63,482
All.-Ch., pfd...	51½	51¾	500	Mackay Cos...	81*	80½	100
Amal. Cop....	81	82¾	55,050	Mackay Cos., p	74½*	73¾	100
Am. D. T....	29*	29*	——	Man. Elev.....	143⅞*	143⅞*	——
Am. Loc.....	59¼	60⅛	5,200	Met. St. Ry...	25⅞*	18	510
Am. Loc., pfd.	117¾*	118¼	800	N.Y. & N.J.Tel	137*	137*	——
Am. Tel & Cbl.	80*	80*	——	Steel, com....	66¾	69¼	382,350
Am. T. & T..	142	140¾	15,295	Steel, pfd.....	124⅜	126⅛	25,867
B. R. T.....	79⅝	79⅜	10,250	W. U. T.....	72	72	1,122
Gen. Elec.....	161½*	164	6,100	West'h, com...	85	85½	1,900
Int.-Met. com.	17	16½	23,000	West'h, pfd...	121*	121¼	50

PHILADELPHIA.

	June 28.	July 2.	Shares Sold.		June 28.	July 2.	Shares Sold.
Am. Rys.....	45¾*	45¼*	——	Phila. Elec....	11¾	11⅞	——
Elec. Co. of A.	12⅜*	12⅝*	——	Phila. R. T....	28	28¾	——
Elec. St. B'ty.	52⅜*	52	——	Phila. Trac....	91*	91	——
E. S. B'ty, pfd.	49*	49*	——	Union Trac...	52⅛	53	——

CHICAGO.

	June 28.	July 2.	Shares Sold.		June 28.	July 2.	Shares Sold.
Chi. City Ry..	180*	180*	——	Chi. Tel. Co..	134*	132½	——
Chi. Rs., Ser.1.	107*	112¾	——	Met. El., com.	17½*	17½*	——
Chi. Rs., Ser.2.	37⅛	40½	——	Met. El., pfd.	50*	48	——
Com. Edison..	119½	121¾	——	Nat'l Carbon..	92	90	——
Chi. Sub'ws...	24*	22	——	Nat'l C., pfd..	117*	118	——

BOSTON.

	June 28.	July 2.	Shares Sold.		June 28.	July 2.	Shares Sold.
Am. T. & T...	142⅛	140⅞	——	Mex. Tel.....	2¾*	2⅞	——
Cum. Tel.....	133½*	133½*	——	Mex. Tel., pfd.	6*	6*	——
Edison E. Ill..	248	250	——	N. E. Tel.....	133½	133¾	——
Gen. Elec.....	161	164	——	W. T. & T....	10½	10½*	——
Mass. E. Ry..	13	13½*	——	W. T. & T., p.	86	85	——
Mass. E. R. p.	69½	70½	——				

*Last price quoted.
Shares sold are for week June 28 to July 2.

DIVIDENDS.

Boston & Northern Street Railway Company, semi-annual dividend 3 per cent, payable Aug. 1.

Brooklyn City Railroad Company, quarterly, 2½ per cent, payable July 15.

Consolidated Power & Light Company, of South Dakota, preferred, quarterly, payable July 1.

Gamewell Fire Alarm Telegraph Company, quarterly, 1¼ per cent, payable July 1.

Manchester (N. H.) Traction, Light & Power Company, quarterly, 2 per cent, payable July 15.

New England Telephone & Telegraph Company, quarterly, 1½ per cent, payable July 15.

Oklahoma Gas & Electric Company, quarterly 1¾ per cent, payable July 15.

Old Colony Street Railway, semi-annual, 3 per cent, payable Aug. 1.

Pacific Coast Power Company, 2 per cent, payable July 16.

Philadelphia City Passenger Railway Company, semi-annual, 7½ per cent, payable July 10.

Philadelphia & Grays Ferry Passenger Railway Company, semi-annual, 4 per cent, payable July 7.

Quincy (Ill.) Gas, Electric & Heating Company, 1 per cent, payable July 20.

San Diego (Cal.) Consolidated Gas & Electric Company, quarterly, 1¾ per cent, payable July 15.

Standard Underground Cable Company, quarterly, 3 per cent, payable July 10.

Twin City Rapid Transit Company, common, quarterly, 1¼ per cent, payable Aug. 16.

United Metals Selling Company, quarterly, 5 per cent, payable July 1.

Union Switch & Signal Company, common and preferred, 3 per cent, payable July 10.

PURCHASE OF THE WILMINGTON GAS & ELECTRIC COMPANY.—C. H. Geist, of Philadelphia, has purchased from Lawrence McCormick and K. L. Ames their interests in the Wilmington (Del.) Gas & Electric Company. These three financiers recently bought the property from John and James Dobson, of Philadelphia, as stated in last week's issue, but now Mr. Geist has made the transaction a personal affair. He owns all of the common and preferred stock and bonds of the company, and the transfer involved about $2,500,000. The property will be taken over some time in August, and changes will then be made in the board of directors and in the management of the company. Mr. Geist will operate this plant along with a number of other smaller companies which he now controls. These include the Northern Alabama Gas Company, at Florence, Ala.; Michigan City (Ind.) Gas & Electric Company; the Lansing (Mich.) Fuel & Gas Company, and the Plymouth (Ind.) Light Company. It is his intention to increase the company's business in Wilmington by the adoption of the most modern methods, and he believes that the output will be doubled within the next three years. One of the first improvements will be the erection of a new 1,000,000-ft. holding tank, and the present plant will be enlarged at once.

ELECTRIC VEHICLE COMPANY REORGANIZATION.—Details of the plan for the reorganization of the Electric Vehicle Company have been finally given out. The holders of the common stock, which amounts to $20,000,000, will be compelled to pay an assessment of $1 per share for the privilege of exchanging 20 shares of their old stock for one share of the stock of the reorganized company. The preferred shares under the reorganization plan are entitled to new stock at the rate of 20 of the old for one share of the new common stock without the necessity of paying the assessment. The new company is capitalized at $2,000,000 preferred stock, compared with $9,000,000 in the old company, and $1,000,000 of common stock, as against $11,000,000 in the old company. Holders of the company's $1,521,000 of bonds are to be given $620 in new preferred stock for every $1,000 bond. The new officers are: Herbert Lloyd, of Philadelphia, president; H. W. Nuckols, Hartford, treasurer and general manager; directors: W. G. Henderson, Philadelphia; W. H. Atwood, New Haven, and K. D. Schley, New York.

CINCINNATI LIGHTING COMPANY DEAL.—Stockholders of the Union Gas & Electric Company, of Cincinnati, have received circular letters from the underwriting syndicate of that company, suggesting a plan whereby the business may be turned over to the Columbia Gas & Electric Company, together with the lease of the property of the old Cincinnati Gas & Electric Company. It states that an offer has been made for the stock of the Columbia Gas & Electric Company and that negotiations have long been under way. Some time ago A. S. White secured about 50 per cent of the holdings, it is said, and they are now in possession of the Columbia Company.

DELAWARE COUNTY (PA.) ELECTRIC COMPANY.—The Delaware County (Pa.) Electric Company, which was recently incorporated to own and control four electric light properties in that locality, has made a contract with the Philadelphia Electric Company for its energy. There will be an issue of $300,000 first mortgage bonds, which will be used for extensions and improvements. The new company will be controlled by the Associated Gas & Electric Company of New York, a concern which is now operating 14 gas and electric light properties in New York, Pennsylvania and Ohio.

KINGS COUNTY LIGHTING COMPANY.—In its report to the Public Service Commission, in connection with its application for permission to issue $450,000 of bonds, of which $200,000 are to be used for a new plant, the Kings County Lighting Company gives its total assets as $5,279,413; this includes franchises, lands and all other property. The liabilities are set down as funded debt, $2,603,000; current liabilities, $120,790; stock, $2,000,000, and corporate surplus, $518,754. The application has not yet been decided.

LACLEDE GAS LIGHT COMPANY DEAL.—It is now stated that the price received by the North American Company for the 77,000 shares of stock of the Laclede Gas Light Company of St. Louis, which were recently sold to bankers representing a syndicate of St. Louis capitalists, was 97½ to the bankers and 98½ to the syndicate, giving the bankers 1 per cent commission. The stock is now selling at about 101.

UNION RAILWAY, GAS & ELECTRIC COMPANY.—Although no official announcement has been made of the interests to be taken over by the newly incorporated Union Railway, Gas & Electric Company—an $18,000,000 corporation—it is understood that it will be a holding company for the interests of E. W. Clark & Company, of Philadelphia, and Hodenpyl, Walbridge & Company, of New York. Among the properties in which these firms are interested are: the East St. Louis & Suburban Company, capitalized at $14,000,000, and owning a number of lighting and traction concerns in Southwestern Illinois; the St. Joseph, Mo., Railway, Light, Heat & Power Company, capitalized at $5,060,000; the Peoria, Ill., Railway & Light Company, capitalized at $3,500,000; the Springfield, Ill., Railway & Light Company, capitalized at $3,000,000; Columbus, Ohio, Railway & Light Company, capitalized at $5,000,000; the Grand Rapids, Mich., Railway Company, capitalized at $3,500,000; the Saginaw, Bay City Railway & Light Company, capitalized at $3,000,000, and the Saginaw Gas Company with capital of $400,000.

CLEVELAND RAILWAY COMPANY'S MORTGAGE.—A mortgage for $3,179,000 has been filed in the county recorder's office here by the Cleveland Railway Company in favor of the Citizens' Savings & Trust Company and Allan B. Forbes, of New York. The mortgage covers all the property of the company including the lines formerly owned by the Forest City and Low Fare Railway Companies. Arrangements have been made to sell the bonds to N. W. Harris & Company, of New York, and this house is represented in the mortgage by Mr. Forbes. This money will be used to retire the $2,026,000 Cleveland City Cable Company bonds, due July 1, and the $1,000,000 East Cleveland Railway bonds, due March 1, 1910. Provision is made in the mortgage for leasing, conveying or transferring any of the lines.

PROTEST AGAINST THIRD AVENUE PLAN.—Various stockholders of the Third Avenue Railroad Company have entered a protest with the Public Service Commission against the adoption of the reorganization plan proposed by the bondholders' committee. A protest has also been entered by the tort creditors' committee. The stockholders and these creditors assert that under the proposed plan they are not given a fair interest in the reorganized property. The bondholders' committee has intimated that if the Public Service Commission fails to approve its reorganization plan, the bondholders may bid in the road at the foreclosure sale, and thus entirely wipe out the existing stock. The commission has not yet had any hearing upon the plan.

LONG ISLAND ELECTRIC RAILWAY.—The Public Service Commission has received an application from the Long Island Electric Railway Company asking permission to reduce its capital stock from $2,100,000 to $600,000. This company was originally incorporated with an authorized capital of $600,000, and subsequently consolidated with the New York & North Shore Railway Company, which had an authorized capital of $1,000,000. The consolidation agreement of these companies puts down the North Shore stock as $1,500,000, and the consolidated company now states that it does not know for what purpose the additional $500,000 was authorized or issued. It desires to return to its original capitalization.

KEYSTONE TELEPHONE COMPANY BONDS.—Newburger, Henderson & Loeb and Fisk & Robinson are offering to the public $1,000,000 of first mortgage 5 per cent bonds of the Keystone Telephone Company, of Philadelphia; the price is 92½ and interest. Formal announcement is also made that $600,000 of three-year 6 per cent collateral notes, due March 1, 1919, have been called for redemption Sept. 1, 1909. The bankers mentioned will accept these notes in exchange for the bonds at the price at which the latter are offered to the public.

NATIONAL CARBON COMPANY DIVIDEND.—It is unofficially announced by interests closely allied with the National Carbon Company, that the dividend on the common stock will be increased some time during the present year. The common stock for some time has been paying 4 per cent annually, and it is expected that the rate will be increased to 5 per cent and possibly 6. The company's earnings are said to be very satisfactory, and the outlook for business is described as the best since the organization of the corporation.

CLEVELAND & ZANESVILLE RAILWAY BONDS.—A mortgage has been filed in Cleveland for $6,000,000 on the property of the Cleveland, Barberton, Coshocton & Zanesville Railway Company to secure a bond issue of that amount. With the proceeds of this issue a new railway line of 190 miles will be constructed. Except 12 miles the entire line will be built on private right of way. The officers of the new company are: J. J. Breitinger, president; W. E. Brooks, vice-president; J. Harry Knisely, secretary, and B. E. Ottman, treasurer.

MASSACHUSETTS LIGHTING COMPANIES.—The May report of the Massachusetts Lighting Companies shows gross earnings of $54,866, which is an increase of $9,297 over May of the previous year. This makes a total increase of $40,244 for the first five months of the present year. The regular quarterly dividend of 1½ per cent was not only declared at the recent meeting of the directors, but an extra dividend of one-quarter of 1 per cent was also declared. This is the second extra dividend that has been declared this year.

INTERBOROUGH'S BONDS SOLD.—J. P. Morgan & Company have purchased the $10,000,000 of 5 per cent bonds of the Interborough Rapid Transit Company which are just being issued. The Public Service Commission dismissed the application of the company for the issuance of these bonds on the grounds that its permission was not necessary, as the bonds were a part of the $55,000,000 issue which was approved by the commission on April 24, 1908.

NEW YORK STATE GAS COMPANY SALE.—The Public Service Commission of the Second District has announced the sale of the properties and rights of the Mutual Gas Company, Ltd., of Wellsville and Andover, N. Y., to the Mutual Gas & Fuel Company, Ltd. The price paid was $222,363, and it is stated that the properties will be improved and put in first-class condition.

REPORTS OF EARNINGS.

	Gross earnings.	Expenses.	Net earnings.	Charges.	Surplus.
Dallas (Tex.) Electric Corporation:					
April, 1909	$100,963	$61,678	$39,285	$28,831	$10,453
April, 1908	91,616	60,745	30,870	30,062	808
Detroit United Railway Company:					
May 1909	664,506	389,178	287,997	154,932	133,065
May, 1908	599,643	365,375	238,232	135,661	102,571
Electric Properties Company:					
Year ended April 30, 1909	231,188	55,327	175,861	135,669	40,192
Year ended April 30, 1908	280,671	87,200	193,471	179,344	14,127
Galveston-Houston Electric Company:					
April, 1909	93,720	55,245	38,475	21,258	17,215
April, 1908	83,446	48,573	34,873	20,582	14,290
Kansas City Railway & Light Company:					
April, 1909	542,376	300,783	241,593	153,846	87,746
April, 1908	492,472	267,657	224,814	151,016	73,798
Lowell (Mass.) Electric Light Corporation:					
April, 1909	27,981	17,395	10,585	4,184	6,401
April, 1908	27,364	15,525	11,839	4,822	7,016
Milwaukee Electric Railway & Light Company:					
May 1909	346,907	161,685	185,224	105,793	79,431
May, 1908	326,376	165,716	160,659	92,901	67,758
Milwaukee Light, Heat & Traction Company:					
May 1909	115,924	29,541	86,382	63,319	23,063
May, 1908	111,768	29,194	82,573	59,848	22,724
Northern Texas Electric Company:					
April, 1909	97,836	56,532	41,304	17,189	24,115
April, 1908	79,351	45,466	33,885	15,050	18,835
Rochester & Eastern Rapid Transit Railway Company:					
Quarter ended March 31, 1909	50,424	39,543	10,881	3,417	7,463
Quarter ended March 31, 1908	54,191	49,592	4,598	3,241	1,356
St. Joseph (Mo.) Railway, Light, Heat & Power Company:					
May 1909	77,187	42,621	34,566	21,537	13,029
May, 1908	72,447	40,232	32,215	20,597	11,618

GENERAL NEWS

Construction News.

PHOENIX, ARIZ.—John W. Sharpe has petitioned the City Council for a franchise to construct and operate an electric light system and gas plant in Phoenix.

COLFAX, CAL.—W. S. Fletcher, of Forest Hill, Cal., is contemplating the construction of an electric railway between Colfax and Forest Hill for both freight and passenger service. It is said that work will commence on construction of the road within 30 days.

LOS ANGELES, CAL.—Captain Amos A. Fries, of the United States Engineer Office, has under consideration the application of the Edison Electric Company to construct a high-span transmission line over the channel between Wilmington and Long Beach harbors, near the plant of the San Pedro Salt Company.

OAKLAND, CAL.—Work will soon commence on the construction of the proposed new power plant of the Oakland Light & Power Company at the corner of First and Alice Streets. It is said that the plant will have an output of 25,000 hp. The company is capitalized at $1,250,000.

SACRAMENTO, CAL.—The Central Traction Company has awarded the contract for the construction of an electric railway from Fifth and J Streets to the Agricultural Park, a distance of about 3½ miles, to Harry J. Gray, of Sacramento. Bids will be asked for in about two months for the construction of an electric railway from the terminus of the line at Agricultural Park to connect with the company's line at Lodi. George W. Pelter is vice-president of the company.

CANON CITY, COL.—The Royal George Power Company, recently incorporated, it is said will develop the water rights filed on by the Webster Park Canal & Power Company and the Grape Creek Pipe Line & Power System, which provide for a reservoir to hold 2,150,000,000 cu. ft. of water, to be located 1000 ft. higher than the Royal Gorge at the railroad grade. The dam, with intake canal and outlet, will cost about $5,000,000 and will be located in Webster Park, south of the gorge. It is proposed to take 12,000 cu. ft. of water per second from the Arkansas River at Texas Creek and conduct it through a canal 10 ft. deep, 16 ft. wide at the bottom and 36 ft. wide at the top and 13 miles in length. The power will be utilized to generate electricity, which will be transmitted to El Paso and Pueblo counties, where stations will be erected for pumping the underflow from the eastern slope of the range. The cost of the Grape Creek project is estimated at $1,600,000. G. A. Taft, R. E. Ellison and others are interested.

CONEJOS, COL.—The streets of the towns of Conejos and Antonito are in darkness, owing to the Conejos Flour Mill having been destroyed by fire. The power plant in the mill furnished electricity in both towns for lamps and motors. It is understood that the mill and power plant will be rebuilt at an early date.

MONTE VISTA, COL.—The Monte Vista Electric & Gas Light Company is contemplating the installation of new and larger boilers. N. H. Chapman is manager.

DANBURY, CONN.—Arrangements are being made to erect a large hat factory in Danbury, contracts for the construction of which have been awarded to Tracy Brothers Company, of Waterbury, Conn. The factories of the Lee Hat Manufacturing Company, the Lee Soft Hat Company, McLachlen & Company and the S. A. G. Hat Company will be consolidated into one plant. A complete electric plant will be installed.

DURHAM, CONN.—The question of lighting the town by electricity is under consideration, the service to be furnished from the plant of the Middletown Electric Light Company.

WATERBURY, CONN.—The Connecticut Company has made application to the Board of Aldermen for permission to erect a dam on the Naugatuck River in this city, near the present distributing plant of the company.

WASHINGTON, D. C.—Bids will be received until July 13 by the Bureau of Supplies and Accounts, Navy Department, for furnishing at the various navy yards and naval stations the following supplies: Brooklyn, N. Y., Schedule 1391—four ash-hoisting engines. Annapolis, Md., Schedule 1392—one generating set erected in place. Bids will also be received until July 20 for the following: Naval Training Station, Newport, R. I., Schedule 1393—furnishing and installing a boiler, stoker, stack and connecting flues and constructing foundation for boiler; also all piping and accessories and for removing portions of dry room wall and roof. Proposals will also be received until August 2 as follows: Mare Island, Cal., Schedule 1394—two electric jib cranes.

FORT PIERCE, FLA.—The St. Lucie Ice Company, which was recently granted a franchise in this city, is planning to install an electric plant at a cost of about $8,000, work on which will commence about Oct. 1. R. White is president and general manager.

PANACEA, FLA.—Plans are being considered for the construction of an electric railway from Thomasville to Panacea, via Thomasville, for which surveys will soon be made.

ST. PETERSBURG, FLA.—The St. Petersburg Electric Light & Power Company is reported to be interested in a project to establish an electric light system in Bayboro.

ATLANTA, GA.—The Council Committee on Electricity has voted favorably on the application of the Central Georgia Power Company for a franchise to sell power for lights and manufacturing purposes in Atlanta. It is stated by W. J. Masse, president of the Central Georgia company, that in the neighborhood of $1,500,000 is available for the construction work planned by the company.

BREMEN, GA.—At an election held recently the citizens voted to issue $8,000 in bonds for the construction of an electric light plant.

ELBERTON, GA.—The City Council is said to be considering plans to increase the output of the municipal electric light plant, for which $5,000 in bonds were recently voted. It is stated that additional power may be developed at Beaver Dam Creek and a steam plant installed as an auxiliary to the water power plant. Park A. Dallis, of Atlanta, Ga., is engineer.

WAYCROSS, GA.—At an election to be held July 28 the citizens will vote on the proposition to issue $35,000 in bonds for the construction of an electric light plant. The city voted against the proposition at the election held June 19.

CHAMPAIGN, ILL.—The capital stock of the Home Telephone Company of Champaign County has been increased from $200,000 to $250,000.

KANKAKEE, ILL.—The City Council has granted the Chicago-Champaign & Kankakee Interurban Company a 50-year franchise to construct an interurban railway on Schuyler Avenue and River Streets.

INDIANAPOLIS, IND.—The contract for the installation of the electrical work in the new city hall building has been awarded to the Hatfield Electric Company, its bid being $8,151, exclusive of fixtures.

NOBLESVILLE, IND.—It is the intention of the Noblesville Heat, Light & Power Company to extend and improve its plant, for which purpose it has increased its capital stock from $50,000 to $75,000. T. C. Reynolds is president of the company and A. C. Holliday, secretary.

WARSAW, IND.—Bids are being asked by the Commercial Telephone Company of this city for the installation of a new toll board.

CEDAR RAPIDS, IA.—The Cedar Rapids & Iowa City Railway & Light Company contemplates enlarging its plant and making improvements in boiler room at a cost of $125,000. Isaac B. Smith is secretary.

INDEPENDENCE, IA.—Plans have been prepared by the Arnold Company, of Chicago, Ill., consulting engineers, for rebuilding the municipal electric light plant, the cost of which is estimated at $8,350. It is proposed to change the system from 133-cycle to 60-cycle, 2-phase system.

FRANKFORT, KY.—The Frankfort Home Telephone Company purchased at auction recently a franchise to operate a telephone system in Frankfort. The amount paid for the franchise was $150.

FRANKFORT, KY.—Bids will be received by the Kentucky State Board of Control for Charitable Institutions, Frankfort, Ky., until July 12, for material and labor required for the erection of boiler and engine house, smokestack and tunnel; also for two water-tube boilers, mechanical stokers and feed-water heater, engine and generator on the premises of the Feeble Minded Institute in Frankfort, Ky. Plans and specifications are on file in the office of the Kentucky State Board of Control for Charitable Institutions in Frankfort, Ky., and in the office of D. X. Murphy & Brother, architects, Louisville, Ky. Albert Scott is president of the board.

PEAK'S MILL (P. O. FRANKFORT), KY.—The City Council has passed an ordinance providing for the construction of an electric light plant and water works system, to cost $40,000.

TALLULAH, LA.—Plans are being made by the city to establish an electric light plant, the equipment of which will include a 75-hp compound engine, direct connected to a 60-kw, 3-phase, 60-cycle, 2300-volt, alternating-current generator, and for which bids will be opened about July 10. J. E. Craig is city engineer.

AUGUSTA, ME.—The Lewiston, Monmouth & Greene Telephone Company has purchased the pole rights on Lakeview Avenue from the Maine Telephone Company. It is said that the company will rebuild the line as far as Sear's Corner.

WALKERSVILLE, MD.—The City Council is considering the question of establishing an electric light plant.

BEVERLY, MASS.—The Beverly Gas & Electric Company has applied to the State Board of Gas and Electric Light Commissioners, asking for permission to do business in Topsfield, under a special act of the Legislature passed this year.

FALMOUTH, MASS.—The Buzzards Bay Electric Company has awarded the contract for the construction of its power house to T. C. Bourne, of Falmouth.

PEABODY, MASS.—The committee on remodeling the municipal electric light plant has awarded the contract for the new switchboard at the power station to the Condit Electric Company, of Boston, Mass., for $5,000.

PITTSFIELD, MASS.—Preparations are being made by the Pittsfield Electric Company to remove its substation from the present location on Carson Avenue, a short distance south of where it now stands.

SOUTHBRIDGE, MASS.—The Selectmen are considering a proposition to substitute tungsten lamps for street lighting. The contract with the Webster & Southbridge Gas & Electric Company for street lighting expired June 1. It is said that the contemplated change may save the town from $800 to $900 per year.

SPRINGFIELD, MASS.—Important changes are being made by the United Electric Light Company at its Indian Orchard and State Street stations. An 800-hp Corliss engine is being removed from the State Street station to make room for the street lighting apparatus, which will be brought from the station at Indian Orchard, and will enable the company to control the entire street lighting system from the downtown station and to be independent of the water power plant. The alternating-current generator which was driven by the Corliss engine will be removed to the Indian Orchard station and operated by water power. The direct-current generator, which was also driven by the engine, is being removed. The company is gradually discarding its direct-current apparatus, and it is hoped to have the entire system changed over within a year. The present changes will make it possible for the removal of the high-tension transmission lines between Indian Orchard and Springfield.

MT. PLEASANT, MICH.—The Chippewa River Power Company has applied to the City Council for a franchise to erect transmission lines and other apparatus in Mt. Pleasant for the distribution of electricity for lamps, motors, etc., for a term of 30 years.

ONAWAY, MICH.—The capital stock of the Onaway Telephone Company has been increased from $4,000 to $5,000.

ANOKA, MINN.—At a special election, held June 26, the citizens voted to issue $60,000 in bonds, of which $40,000 will be used for the purchase of the local light and water plant and $20,000 for improvements.

BEMIDJI, MINN.—The Plantagenet Telephone Company has decided to extend its telephone line during this summer from Lake Plantagenet to Lake George, a distance of 20 miles. A. H. Jester is president.

JACKSON, MISS.—Plans are being made by the Cumberland Telephone & Telegraph Company to install a central energy switchboard with a capacity of 5000 lines.

ELDORADO SPRINGS, MO.—It is reported that B. F. Proctor is planning to construct an electric light plant in Eldorado Springs, machinery for which has already been purchased.

LYONS, NEB.—Arrangements are being made for the construction of a new independent telephone line in Lyons. As soon as the lines are completed in the town, the system will be extended into farming districts.

VALENTINE, NEB.—A. M. Morrisey, village clerk, writes that bids will probably be received about Aug. 1, 1909, for the construction of the proposed municipal electric light plant and water works system, for which bonds to the amount of $40,000 were recently voted.

FRANKLIN, N. H.—The property of the Pemigewasset Electric Company, of Boston, including the mill and dam across the Pemigewasset River at Eastman Falls, in this city, has been purchased by Alvah W. Sulloway. The plant has a minimum output of 1500 hp, of which only a small part is used at present by the Pemigewasset Electric Company, which has an excelsior mill on the west shore. Julian D. Este, of Salem, Mass., is president of the company.

ASBURY PARK, N. J.—The plant and holdings of the New Jersey Consolidated Water & Light Company, in South Elberon, were sold at auction June 23 by John S. Applegate, Jr., of Red Bank, N. J., acting as special master in chancery in a suit brought by John Shepherd. The plant was purchased by F. Bailey, of Jersey City, N. J., who, it is understood, represented the large stockholders in the company for $150,000. It is said that the plant will continue to operate under the same management that has controlled it for some time. C. Conover is manager of the company.

DOVER, N. J.—Work has commenced on the foundation to the new power house of the Morris County Traction Company in Dover, which will be equipped with generators of 1000 hp, to supplement the power now obtained from the plant of the Dover Electric Light Company.

CLOVIS, N. M.—The City Council has awarded the contract for the construction of an electric light plant and water works system to Marshall Brothers, of Las Animas, Col., for $55,000.

ALBANY, N. Y.—The contract for rewiring the executive mansion in Albany was awarded by the State architect to Frost & Sheldon for $6,000.

BROOKLYN, N. Y.—It has been decided to light Fort Greene Park with electricity. The Edison Electric Illuminating Company of Brooklyn has been instructed to place 90 tungsten lamps in the park.

BROOKLYN, N. Y.—The South Flatbush Railway Company has withdrawn its application, filed on June 11, for permission to construct a rectangular railway from Avenue Q station of the Brighton Beach elevated line to Flatbush Avenue, the reason being given that the company is to be reorganized, and later an amended application will be filed with the Public Service Commission.

BUFFALO, N. Y.—Sealed proposals will be received at the office of the Department of Public Works until July 10 for furnishing and installing underground cables for the Police and Fire departments in connection with the placing of all overhead wires in underground conduits within certain districts in the city. Francis G. Ward is commissioner.

DELMAR, N. Y.—The Town Board is considering the question of entering into a contract with the Albany Illuminating Company for furnishing electricity for lighting the town. It is expected the transmission lines of the company will be extended out on the Delaware road in a short time. Many of the residents along the line of Normansville, Elsmere, Delmar and Slingerlands have agreed to take electrical service.

FULTON, N. Y.—The City Council, at a special session June 21, offered for sale a franchise for the distribution of electricity for light, heat, power, etc., for which no bids were made.

MALONE, N. Y.—The Public Service Commission, Second District, has authorized the Malone Light & Power Company to mortgage its property and franchise to secure an issue of $40,000 in bonds, which have been authorized by the commission.

NEW YORK, N. Y.—The Board of Estimate and Apportionment has approved the form of contract and specifications for work and materials for the installation of an electric light and power plant in the New York Public Library, Borough of Manhattan.

NEW YORK, N. Y.—Bids will be received until July 20 at the office of the Board of Water Supply, 299 Broadway, New York, N. Y., for furnishing and installing two 12,500,000-gallon steam turbo-turbine pumps; two 25-hp water-tube boilers and all accessories at the Jerome Avenue pumping station, Borough of Bronx. Plans and specifications, with forms of proposal and contract, can be obtained at Room 1515 at the above address. L. Waldo Smith is chief engineer.

NEW YORK, N. Y.—The Board of Aldermen has approved an ordinance appropriating the sum of $100,000 for the preparation of detail plans and specifications for a new fire alarm system in the Borough of Manhattan, the plans to include the location and character of the ducts required, such subways as the city must build for itself, and also for the entire instrumental equipment and central substations required.

TAPPAN, N. Y.—Plans are being prepared by the Rockland Trolley Company for the construction of an electric railway from Tappan to Suffern, and from Stony Point to Nyack, about 30 miles in length. The cost of the railway is estimated at $2,500,000. The company has been organized with the following named officers: B. A. Hegeman, Jr., president; Charles J. Hardy, secretary; Stafford S. Delano, treasurer; A. C. Miller, second vice-president and general manager, and W. H. Coverdale, chief engineer.

MONROE, N. C.—The Icemorlee Cotton Mills Company has awarded contracts for the construction of its No. 2 mill, which will have a 5000-spindle equipment. The plant will be operated by electricity, which will be furnished by the Monroe transmission system of the Southern Power Company, of Charlotte, N. C.

STATESVILLE, N. C.—Arrangements are being made by the Iredell Telephone & Telegraph Company for the construction of a telephone exchange, to cost $3,000.

PIQUA, OHIO.—Contracts have been awarded by the Orr Felt & Blanket Company for the construction of a new mill, which, with equipment, will cost about $200,000. The plant will be equipped for electric motor drive, electricity for which will be furnished by the company's own plant, to be installed. The company manufactures army blankets.

RANDOLPH, OHIO.—It is reported that a number of residents of Randolph are interested in a project for the construction of an electric railway to connect several villages north of this city. The plan includes the building of a railway connecting Dayton, Covington and Piqua Traction Company and the Dayton & Northern Traction Company. The cost of the railway is estimated at $150,000. Vernon Ewing is said to be promoting an organization to act in cooperation with the Dayton Chamber of Commerce.

ZANESVILLE, OHIO.—The Muskingum & Morgan Railway, Light & Power Company, recently incorporated, proposes to construct a power house in Zanesville and to furnish electricity in this city and to the towns and villages between Zanesville and McConnellsville. The company has been organized with the following named officers: Andrew McDonald, president; John J. Adams, vice-president; W. H. Pierpont, secretary, and R. C. Burton, secretary.

ARDMORE, OKLA.—Oscar Ayres and associates are contemplating the construction of a hydro-electric power plant on the Washita River in connection with a proposed railway. M. T. Forsythe, of West Chester, Pa., is engineer.

CORDELL, OKLA.—It is reported that the proposition to issue $10,000 in bonds for the construction of an electric light plant will be submitted to a vote.

MANGNUM, OKLA.—The question of issuing $80,000 in bonds for the construction of a municipal electric light plant is reported to be under consideration.

RYAN, OKLA.—At a recent election the citizens voted to issue bonds to the amount of $69,000, of which $5,000 will be utilized for electric lighting.

WETUMKA, OKLA.—The Franklin Construction Company, of St. Louis, Mo., is reported to have submitted a proposition to the town officials in connection with the installation of an electric light plant.

MILTON, ORE.—A new 200-kw generator has been installed in the municipal electric light plant, and a Leffel water wheel is now being placed. Thomas Taylor is superintendent.

PORTLAND, ORE.—The City Executive Board has awarded the contract for furnishing electricity for lighting the streets and public buildings to the Portland Railway, Light & Power Company for a period of five years. Under the terms of the new contract the company is to supply arc lamps fed from aerial wires at $56 each per year, a reduction of $7.60 per lamp from which the city paid under the former contract. For arc lamps, supplied from underground wires, $75 each per year; electricity for incandescent lamps at 2¼ cents per kw-hour; the lowest previous bid was 3½ cents per kw-hour. Under the new contract the city will save $15,000 a year over the previous tenders submitted by the company.

ALLEGHENY, PA.—Alexander Gray, superintendent of the municipal electric light plant, writes that 16 mercury arc rectifiers, 75 lighting units, have just been installed in the municipal electric light plant, replacing 12 60-lamp Western Electric arc machines and 600 Brush double carbon lamps.

ALLENTOWN, PA.—The County Commissioners have rejected all bids submitted for installing an electric light and power plant at the County Home, at Wescoesville, as none of them came within the amount estimated by the engineers, which was $9,900. The Commissioners will again call for bids.

BELLE VERNON, PA.—The Independent Telephone Company has been granted a franchise to construct and operate a telephone system in Belle Vernon.

COLUMBUS, PA.—The Columbus, New Albany & Johnstown Traction Company has awarded the contract for the construction of an extension of its railway from Gahanna, the present terminus, to Johnstown, to the Dominion Construction Company, of Pittsburgh, Pa.

MIFFLIN, PA.—The West Penn Railway Company has applied to the Township Commissioners for a right-of-way for an electric railway from Dravosburg to Coal Valley.

NORTHUMBERLAND, PA.—Contracts have been awarded by the Pennsylvania Railroad Company for the classification yard to be built at Northumberland at a cost of about $3,000,000, which will be divided with the Northern Central Railway Company. The work will include the construction of a 36-stall roundhouse, a power house, machine, transfer shed and other buildings and about 70 miles of trackage.

PIERRE, S. D.—The Black Hills Traction Company has applied for water rights on Coxey Lake, to be utilized for a water-power development.

NASHVILLE, TENN.—Arrangements are being made by the Belmont College for the erection of a heating, electric lighting and power plant in the campus to be connected by conduits with other buildings.

SPARTA, TENN.—The A. & T. Power Company, recently incorporated, proposes to develop a water power at a cost of about $25,000, which will include the construction of a concrete race and dam. About 400 hp will be developed. J. R. Tubbs is president, and O. H. Anderson is general manager.

STANTON, TENN.—A company has been organized to establish a telephone system in Stanton. The officers of the company are: W. B. Douglass, president; W. S. Mahon, vice-president; F. C. Rawlins, secretary and treasurer, and P. O. Wilkerson, manager.

AMARILLO, TEX.—Plans are being considered by the Amarillo Water, Light & Power Company for extensive improvements to its systems at a cost of about $100,000, and will include the installation of new machinery, extension of mains and sinking four or more new wells, etc.

CHEROKEE, TEX.—Extensive improvements are being made to the Pioneer Telephone Company's ssytem, which will involve an expenditure of about $10,000.

EL PASO, TEX.—The City Council has granted a franchise to R. V. Borden to construct and maintain a telephone system in El Paso.

EL PASO, TEX.—A franchise has been given by the City Council to Richard Caples and W. B. Latta, representing the El Paso & Fort Hancock Interurban Railway Company to construct and operate an electric railway on certain streets in this city.

GREENVILLE, TEX.—The citizens have voted to issue bonds to the amount of $50,000 for improvements to the municipal electric light plant.

KINGSVILLE, TEX.—The Kingsville Power Company is reported to have awarded the contract for the installation equipment for an electric light plant and water works system, including a 150-hp vertical type three-cylinder gas engine to replace the present system to Rathburn Engineering Company, of Toledo, Ohio.

MOUNT PLEASANT, TEX.—The Mount Pleasant & Red Springs Railway will soon be put in operation. The railway will cover the principal districts of the city and extend to Red Springs, one mile distant. The company expects to extend the line to Pittsburgh, 12 miles south, by next summer.

PRICE, UTAH.—The Town Board is considering the question of establishing a municipal electric light plant in Price.

MONTPELIER, VT.—Announcement has been made that the Vermont Telephone Company will make improvements and extensions to its systems in Barre and Montpelier which will involve an expenditure of about $60,000. The common battery system will be installed.

EMPORIA, VA.—The Home Telephone & Telegraph Company, of Henderson, N. C., which recently secured a franchise in Emporia, has commenced work on the installation of a telephone system in this city, to cost $25,000.

EMPORIA, VA.—Work is progressing on the construction of the hydro-electric power plant of the Emporia Hydro-Electric Corporation, for which contract for construction was awarded to Stamper Brothers & Ragland and E. T. D. Myers, of Richmond, Va. The plant will develop 2800 hp, which will be transmitted by electricity to Emporia, one and one-half miles distant. The dam is of concrete, 40 ft. high and 600 ft. long. Contracts for the generators have been awarded to the Westinghouse Electric & Manufacturing Company, of Pittsburg, Pa., and to S. Morgan Smith, of York, Pa., for water wheels. The Ashby Cotton Mill and the Emporia Manufacturing Company (planing mill and box factory) have made arrangements for electrical energy from the plant. The terms of the contract require the completion of the plant by Sept. 1. The Emporia Hydro-Electric Corporation controls the Emporia Light & Power Company, which is reconstructing its plant and installing new equipment to be operated by power from the hydro-electric development. C. P. E. Burgwyn, of Richmond, Va., is engineer in charge of the work.

NORTON, VA.—J. B. Sterrett, of Norton, has purchased the electric light franchise, recently sold by the city, for $3,000.

RICHMOND, VA.—Announcement has been made that the reorganization of the Gould street railway interests would result in the construction of a direct line from Richmond to Washington, by the way of Ashland, to which place the railway has already been built. It is said that work will begin early in the fall at Fredericksburg and Ashland, and will involve an expenditure of several million dollars.

RICHMOND, VA.—The committee on electricity is reported to have rejected all bids for the equipment of the proposed municipal electric light and power plant on the site of the old pump house, and new bids will be received until July 14. Bids were opened for this work on April 27 by E. D. Richardson, chairman of committee on electricity. E. W. Trafford is engineer.

ELLENSBURG, WASH.—Plans have been completed by the City Council for extensions and improvements to the municipal electric light system, which will include the installation of a 250-hp steam engine and a 500-kw generator. Bids will be asked on a new turbine and other equipment. W. B. Leverich is manager.

MOUNT KISCO, WASH.—Bids will be received by John H. O'Brien, Commissioner, Department of Water Supply, Gas and Electricity, 21 Park Row, New York, N. Y., until July 14 for furnishing material and labor for constructing and installing two direct-connected, electrically-driven, vertical pumping units, complete with appurtenances, including electric lighting equipment in the pumping station to be erected at the sewage disposal plant at the village of Mount Kisco, N. Y. Plans and specifications may be seen at the office of the chief engineer, where blank form of proposal may be obtained.

WENATCHEE, WASH.—The City Council has awarded the contract for furnishing power to operate the new city pumping plant to the Entait Power Company for a period of five years. The company not being in a position to furnish the service direct at the present time, it has made arrangements with the Wenatchee Canning Company to connect the station with the plant of the Wenatchee company.

FAYETTEVILLE, W. VA.—The City Council has granted R. H. Dickinson a franchise to erect an electric lighting system in Fayetteville. It is said that electricity for operating the plant will be secured from the Stuart Colliery Company, from which transmission lines will be erected to Fayetteville and Oak Hill. P. Davis is engineer and will have charge of construction. A company will be incorporated to operate the system.

BAYFIELD, WIS.—Plans are being considered for extensive improvements to the municipal electric light plant, which will include the installation of a new boiler and changing the system from single-phase, 133 cycles, 1100-volt to three-phase, 2300-volt, 60 cycles; also, replacing the present street lighting system with magnetite arc lamps and series tungsten lamps, and the installation of a new switchboard. F. M. Herrick, Jr., is manager.

CRANDON, WIS.—The capital stock of the Crandon Telephone Company has been increased from $3,000 to $7,500.

JANESVILLE, WIS.—It is reported that the Wisconsin Telephone Company has decided to erect a new exchange building in Janesville.

MILWAUKEE, WIS.—The Wisconsin Telephone Company has purchased a site in West Allis, on which a telephone exchange building will be erected. The company is planning to have telephone exchanges in all larger suburbs, including Wauwatosa, North Milwaukee, Cudahy and South Milwaukee.

LACOMBE, ALTA., CAN.—The Blindman River Electric Power Company is considering the question of constructing a transmission line to Red Deer, Alta. E. J. Tett is secretary and general manager.

KAMLOOPS, B. C., CAN.—Contracts for additional steam and electrical equipment for the municipal electric light plant, to cost about $13,000, have been awarded as follows: To the Canadian Westinghouse Company, Montreal, Que., for engine and generators, and the Canadian Fairbanks Company, Montreal, Que., for boilers and condensers.

MEXICO CITY, MEX.—The cost of making repairs to the hydro-electric system of the Mexican Light & Power Company, at Mecaxa, about 90 miles from this city, caused by a cave-in of one of the dams, is estimated at $2,000,000. The output of the plant will be increased from 30,000 to 50,000 hp.

Company Elections.

NORFOLK, VA.—The following directors have been elected by the Newport News & Old Point Railway & Electric Company: C. C. Dickinson, John Alvin Young, of New York; John Hertzler, Lancaster, Pa.; John G. Powell, Philadelphia; Austin McLanahan, Baltimore; W. J. Payne, Richmond; Geo. A. Schmelz and W. B. Vest, Newport News.

MOUNT WASHINGTON, MD.—At a recent meeting of the Mount Washington Electric Light & Power Company the following officers and directors were elected: President and general manager, Thomas W. Offutt; secretary and treasurer, Harry J. McIntyre; directors, Thomas W. Offutt, Charles M. Cohn, S. Davies Warfield, Walter K. Townsend and Richard A. Bevan.

New Industrial Companies.

THE TESLA INTERNATIONAL PROPULSION COMPANY, of New York, N. Y., has been incorporated with a capital stock of $1,000,000 by H. C. Quinby, J. F. Valient and J. F. Egan, of New York, N. Y.

THE LUBERTZY BRAKE WORKS, of Portland, Maine, has been chartered with a capital stock of $5,000,000 to manufacture and sell engines and motors. A. H. Peavey is president, and G. E. Burnham is treasurer, both of Kittery, Maine.

THE BLAXSTAFF ENGINEERING COMPANY has filed articles of incorporation with the Secretary of State at Wilmington, Del., with a capital stock of $350,000. The incorporators are: W. F. Donovan, J. M. West and E. E. McWhiney, of Philadelphia, Pa.

THE THOMAS CARBORATOR COMPANY, of Middleburgh, N. Y., has been incorporated with a capital stock of $500,000 by D. D. Frisbee, G. N. Frisbee, of Middleburgh, N. Y.; T. E. Finnegan and G. Lawyer, of Albany, N. Y. The company proposes to manufacture carborators and supplies.

New Incorporations.

NEVADA CITY, CAL.—The Middle Yuba Hydro-Electric Power Company has filed articles of incorporation, with a capital stock of $400,000. The company proposes to construct an electric power plant on the Middle Yuba River, above Graniteville, to supply electricity to the mines in that district, Allegheny and other Nevada and Sierra County mining towns. The directors are: A. D. Foote, C. M. Wilson, W. H. Martin, L. M. Hancock, L. N. Wagner, C. T. Jones and Dr. A. H. Trickell.

PUEBLO, COL.—Articles of incorporation have been filed for the Royal Gorge Power Company, with a capital stock of $2,000,000. The company proposes to operate in Fremont, Pueblo, Teller and El Paso counties. The incorporators are: G. A. Taft, F. M. McMahon, R. E. Ellison, K. Schuyler and C. Spiess.

GAINESVILLE, GA.—The Gainesville Railway & Power Company has been incorporated with a capital stock of $150,000 by A. G. Sharp, of Atlanta, Ga.; W. A. Carlisle, W. H. Slack, H. H. Dean, J. W. Smith and Z. T. Castleberry, all of Gainesville. The company recently bought the property of the Gainesville Electric Railway Company, which consists of eight miles of track. The company is capitalized at $150,000.

WORDEN, ILL.—The Worden Telephone Company has been chartered, with a capital stock of $2,500, by John C. Mueller, Charles W. Piper, L. Dornself, F. W. Stocker and Christ Meyer.

AURORA, IND.—The Cincinnati, Louisville & Indianapolis Electric Railroad Company has been incorporated to construct and operate street and interurban railways between Greendale, Lawrenceburg, Aurora, Rising Sun, Patriot, Florence, Markland, Vevay, Madison and Scottsburg. The company is capitalized at $100,000. The directors are: Amos B. Shuts, John C. Hooven, Clinton E. Hooven, William B. Mayo and Wilbur Hargitt.

RUSHVILLE, IND.—Articles of incorporation have been filed by the Rushville Gas, Heat, Light & Water Company. It has an authorized capital stock of $100,000, and Fred. C. Carroll has been named as president.

VINCENNES, IND.—The Vincennes Western Electric Railroad Company has filed articles of incorporation for the purpose of constructing an electric railway from Vincennes to Bridgeport, Ill., a distance of 14 miles. It is stated that William Sontag, of Evansville, has secured the contract for financing and constructing the proposed railway. The company also proposes to furnish electricity for lighting. Robert V. Stinson is president and J. D. Lacroix, secretary, both of Vincennes.

WICKLIFFE, IND.—The Potako Telephone Company has been incorporated to construct and operate a telephone system and exchange in Wickliffe and throughout Crawford and adjoining counties by Jacob Partenhenew, J. F. Zimmerman and Thomas Smith.

HARDINSBURG, KY.—Articles of incorporation have been filed for the Codyville Telephone Company by Branson M. Elkins, J. W. Tabor, N. H. Adlington, T. Allen, Alonzo G. Allen, Overton Basham and J. Cody.

PROVIDENCE, KY.—The Kentucky Electric Railway Company has been incorporated with a capital stock of $25,000 by B. Sisk, of Silver Run; B. H. Roney, J. T. Edwards, M. E. Edwards, S. Hicks, W. G. Roney and M. G. Roney. The company proposes to construct an electric railway from Dawson Springs to Providence, a distance of 20 miles.

PORT SANILAC, MICH.—The Thumb Telephone Company has filed articles of incorporation, with a capital stock of $10,000.

WELCOME, MINN.—Articles of incorporation have been filed by the Welcome-Triumph Telephone Company, of Welcome. Its capital is given at $50,000, and the incorporators are John Janss, C. E. Bagley, H. A. Miller and others.

TRENTON, N. J.—The Union Railway, Gas & Electric Company has been incorporated with a capital stock of $18,000,000. The company proposes to construct and operate electric railways; also electric and gas lighting and heating plants. The incorporators are: F. R. Hansell, John A. MacPeak and James E. Cotter.

Personal.

MR. E. F. PECK, general manager of the Schenectady, N. Y., electric railway system, has been elected president of the New York State Street Railway Association, which held its annual convention at Bluff Point, Lake Champlain, last week. Mr. Peck is a veteran in the electrical field, but first came into prominence in electric lighting. He had charge of the Thomson-Houston exhibit at the Philadelphia Electrical Exhibition of 1884—the first held in this country—and then had charge of the exhibit immediately following at New Orleans. In 1885 he became general manager of the Citizens' Electric Illuminating Company, of Brooklyn, N. Y., continuing there until 1897. He then started an engineering business as the Peck Electrical Company, of New York, but in 1899 became general manager of the Kings County Electric Light & Power Company, of Brooklyn. He stayed there until 1902, when he was appointed to the position he has ever since held at Schenectady, where he is also president of the Electric Express Company. Mr. Peck is a member of the American Institute of Electrical Engineers and also of the Engineers' Club, of New York. He is widely known in the art and is very popular. Mr. Peck is a brother-in-law of Prof. Elihu Thomson.

E. F. PECK.

PROF. JOHN W. DORSEY has resigned from the faculty of the North Carolina College of Agriculture and Mechanics Arts to assume the chair of Electrical Engineering at the Clarkson School of Technology, Potsdam, N. Y.

MR. F. JNO. BELL, of Montreal, has been appointed general manager of the Mines Power Limited, Cobalt, Ont. The company is building a 10,000-hp hydro-electric plant for supplying power to the various mines in the Cobalt camp.

MR. ELIOT WADSWORTH has been made a partner in the firm of Stone & Webster, of Boston. Mr. Wadsworth has been connected with Stone & Webster for a number of years, and has been an officer in the Stone & Webster Corporation. At present he is in charge of the New York office.

MR. FRANCIS RAYMOND, of Chicago, well known to electrical men, but now connected with the Sheldon School of that city, has been laid up with an attack of typhoid-pneumonia for several weeks. Mr. Raymond's friends will be pleased to learn that he is making satisfactory progress toward recovery.

MR. W. A. REICHERT, for the past three years advertising manager for the Fort Wayne Electric Works, Fort Wayne, Ind., has resigned to accept a similar position with The Power and Illuminating Engineering Company of Alliance, Ohio. This company is a commercial organization, cooperating with central stations to increase the day load on their plants.

MR. F. H. TUBBS has retired from the service of the Western Union Telegraph Company after a period of telegraph service extending over many years. For nearly 30 years Mr. Tubbs has been superintendent of the first district of the western division of the company, with headquarters at Chicago, and he now retires to enjoy a rest that has been well earned, with the best wishes of all his fellow officers in the company which he has served so long and faithfully.

MR. WILLIAM M. SMITH, for a number of years secretary and treasurer of the Chicago Insulated Wire Company, and well known to electrical men in the West, has resigned that position and is now sales manager of the American Insulated Wire & Cable Company, of Chicago, manufacturer of weatherproof electric wires, of which Mr. Nathan T. Brenner is president. Mr. Smith has had a wide experience in the electrical field, previous to which he was engaged in the banking business.

MR. W. H. PALMER, JR., secretary and treasurer of the New York Transportation Company, was badly hurt last week while in his automobile on Eleventh Avenue, New York, through the carelessness of an express wagon driver who was on the wrong side of the street and who sidewiped his car. Mr. Palmer received serious internal injuries and was taken to the New York Hospital. Mr. Palmer is a member of the

American Institute of Electrical Engineers and well known in electrical circles.

MR. C. E. GROESBECK has been elected vice-president of H. M. Byllesby & Company, of Chicago, and will have charge of the company's interests on the Pacific Coast hereafter. Mr. Groesbeck's headquarters will be at Tacoma, Wash., where the company has recently purchased the property of the Tacoma Gas Light Company. Mr. Groesbeck has been with the Byllesby interests for some time, and was formerly in charge of the company's work at Mobile, Ala. Before that he was connected with the selling department of the General Electric Company.

MR. W. J. LLOYD, for a number of years assistant district superintendent for the Western Union Telegraph Company at Chicago, has been promoted to be superintendent of the district, having headquarters in Chicago, succeeding Mr. F. H. Tubbs. Mr. Lloyd is one of the best known of the telegraph officials of Chicago, and has worked his way up from the bottom of the ladder, beginning as a messenger boy in Dubuque, Ia. He later became an operator, and about 20 years ago he came to Chicago, where he has served successively as operator, division chief, wire chief, chief operator, manager of the Board of Trade office, assistant district superintendent, and now superintendent. In handling unusual demands for telegraphic facilities, as in the case of great national conventions and the like, Mr. Lloyd has been conspicuously successful, and has won the admiration of large users of the telegraph, such as the Board of Trade and the daily press, as well as of his associates in the company.

Obituary.

JOHN H. MILLER, general manager of the Springfield Railway Company, Springfield, Ohio, died on the afternoon of June 29, as the result of illness caused by a stroke of paralysis in January of this year. Serious complications set in recently. Mr. Miller had been manager of the company continuously for 19 years.

Trade Publications.

LOW AND MIXED PRESSURE TURBINES.—The various types of Curtis steam turbines for low pressure and mixed pressure are illustrated in Bulletin No. 4669, issued by the General Electric Company. The bulletin also contains curves showing tests of an engine in combination with a low-pressure Curtis machine and a chart showing the power output and costs which indicate the increased capacity and economy secured by installing such sets.

DIAMOND H SWITCHES.—The Hart Manufacturing Company, Hartford, Conn., has issued a handsome catalog devoted to its line of Diamond H switches, which includes push-button, rotary flush and rotary surface switches, and automatic door switches. Owing to the excellent illustrations showing mechanisms and methods of operation, and the clearness of the accompanying descriptions, the pamphlet, in addition to its commercial object, serves the purpose of a concise treatise on house electrical switching service.

GASKETS AND BELL MOUTHS.—Bulletin No. 4670 of the General Electric Company, Schenectady, N. Y., covers gaskets and bell mouths for conduit wiring, marine railway car equipments and underground circuits. The illustrations in the bulletin consists of dimension diagrams of the soft rubber gaskets and metallic bell mouths, and a complete set of tables enables the customer to determine the size of bell mouths required for any particular service, and to ascertain readily the gasket which should be used with it.

Business Notes.

MEAD-MORRISON MANUFACTURING COMPANY announces that it has taken over the business of George W. McCaslin and John A. Mead & Company, giving it the absolute control of the McCaslin Overlapping Gravity Bucket Conveyor. The New York address of the company is 11 Broadway.

ROTH BROS. & COMPANY, Chicago, have secured a contract for eleven motors for use in the new plant of the Sanitary Laundry Company, Chicago. Some of the motors are for direct connection to mangles and other machines, and some are for belt driving through shafting. Postel & Linn were the engineers for the Sanitary Laundry Company.

THE HARVARD ELECTRIC COMPANY, of New York and Chicago, is notifying the trade of alleged infringements of the Harvard "hook type" sectional switch boxes. The Harvard Company states that it is the sole owner of patents issued and patents pending, covering the construction of sectional boxes that "hook" together, identical with the illustrations in the Harvard catalog.

HIGH-VOLTAGE TRANSFORMERS.—The Central Electric Company, Chicago, Ill., has issued a new bulletin descriptive of high-voltage transformers for use in serving consumers directly from high-tension lines. A considerable amount of data is given as to construction of these transformers, and attention is particularly called to the special bushings, which are claimed to give an insulation strength much greater than has heretofore been secured. The same company has also just issued a price list of electrical supplies, comprising 30 pages.

MR. JOSEPH H. WILLIAMSON, for 18 years business manager of the Manufacturers' Advertising Agency of New York, and for 7 years the business manager of the Viennot Advertising Agency of Philadelphia, but who resigned from the Viennot Agency October, 1907, and since then to April 1, 1909, had charge of the New York business on a salary basis, has opened an office at 719 Temple Court, New York, as a representative of trade journals. Mr. Williamson is favorably known by publishers of trade papers throughout the United States.

NEW NERNST LAMPS.—The instantaneous lighting Westinghouse-Nernst lamps exhibited at the Atlantic City Convention of the National Electric Light Association mark another important step in the development of the glower system. The desirable feature of lighting instantaneously is accomplished by the substitution of a new form of heater for the old platinum heater. This heater becomes luminous immediately upon the passing of the current, and in addition to producing light instantaneously is so constructed that it causes the glower itself to light in ten seconds. The Nernst Company announces that on and after July 1 it will be prepared to deliver 88,110 and 132 watt, 220-volt type alternating-current and direct-current lamps equipped with the instantaneous lighting burners.

Weekly Record of Electrical Patents

UNITED STATES PATENTS ISSUED JUNE 29, 1909.

[Conducted by Wm. F. Bissing, Pat. Law, 2 Rector Street, N. Y. City.]

926,088. ELECTRIC CURRENT COLLECTOR; A. H. Angle and L. R. Hecker, Philadelphia, Pa. App. filed July 13, 1907. For underground systems in which the collector is provided with two wheels which swivel and cushion with relation to the oscillating portion of the carrying device.

926,098. APPARATUS FOR INDICATING THE PASSAGE OF A TRAIN AT DEFINITE POINTS OF A TRACK; J. E. Colas, Paris, France. App. filed Feb. 7, 1908. Arranged upon the locomotive or track so that by the contact of a movable abutment the device is actuated. A permanent magnet and a double commanding lever, controlled by returning springs, are used.

926,128. ELECTROLYTE CONDENSER; I. Moscicki, Gambach, near Fribourg, Switzerland. App. filed Oct. 29, 1907. An aluminum electrolyte condenser having aluminum electrodes immersed in the electrolyte supplied with alternating current and means for causing one directional current to flow through the electrodes.

926,148. MOLDING BRANCH BLOCK; E. Sullivan, New York, N. Y. App. filed April 17, 1906. Two adjacent ends of the molding are provided with a capping and a branch block having grooves for the mains and branches interposed, the engagement between the capping and shoulders on the block forming the sole means of support of the block.

926,154. PANEL BOARD; H. S. Walker and H. L. Van Valkenburg, Philadelphia, Pa. App. filed July 17, 1908. The panel board and the linings are secured vertically in alignment with the exterior woodwork surrounding the opening in the partition of the board.

926,162. TRANSMITTING DEVICE FOR TELEGRAPH OPERATORS; W. C. Achgill, Oklahoma, Okla. App. filed Nov. 30, 1908. The body portion of a cabinet has its lower rear edge hinged and is provided with two finger keys, one to make the dot and the other the dashes.

926,164. CIRCUIT CONTROLLER; W. L. Bliss, New York, N. Y. App. filed Aug. 4, 1904. Permits current to flow in one direction and prevents its flow in the opposite direction by means of an electrolytic valve and a switch operated automatically to remove the valve from operative relation with the circuit when the current flows.

926,165. LIGHTING SYSTEM; W. L. Bliss, New York, N. Y. App. filed June 22, 1904. Car lighting system in which the generator is regulated to maintain constant battery current at constant speed irrespective of the amount of current consumed by the translating devices.

926,175. SWITCHING APPARATUS; M. S. Conner, Rochester, N. Y. App. filed May 19, 1904. Party line selective system having a plurality of actuating buttons, switch springs therefor, and a latch frame for the buttons which lock the buttons in their depressed position.

926,185. ELECTRIC WATER HEATER; W. E. Hayes, Omaha, Neb. App. filed March 2, 1909. Employs a core and screw plug of small compact form to carry a resistance coil immersed in the water to be heated.

926,188. HEATING DEVICE; J. R. Holley, Bristol, and E. D. Holley, Forestville, Conn. App. filed Sept. 8, 1908. A flat face carries the heating device, the face being formed of a thin layer of mica and the wire being in the form of a flat ribbon.

926,192. DYNAMO-ELECTRIC MACHINE; L. J. Hunt, Rhyl, England. App. filed June 22, 1906. An induction motor having a stator with a compound winding supplying two or more parallel paths through which the current flows to produce a multipolar field. Equipotential points in the winding are joined, thus producing a field of another number of poles. Two separate windings are employed on the rotor and the connections thereon may be reversed; thus obtains speeds corresponding to the numbers of poles, to the difference of the numbers and to the sum of the numbers.

926,199. TOLL APPARATUS FOR TELEPHONE EXCHANGES; S. J. Larned, Chicago, Ill. App. filed July 7, 1902. The toll device of the substation is controlled by a switch at the central office and one

or both of the manual keys at the central office is dispensed with, the toll device being actuated by the opening of the operator's connection switch.

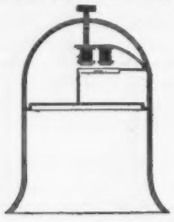
926,225. DYNAMO-ELECTRIC MACHINE; J. A. Williams, Cleveland, Ohio. App. filed Sept. 13, 1906. For explosive engines in which the armature has a core provided with a plurality of wings which co-operate with the pole pieces to increase the number of alternations of flow of magnetic lines for each revolution.

926,236. ELECTRIC FURNACE; J. Bouneau, Paris, France. App. filed July 17, 1907. An electric furnace having a reaction chamber, a passage above the same with a sloping floor, an uptake therefrom and carriages carrying electrodes in the chamber, the electrodes being supplied with current through the rails on which the carriage is run.

926,243. SYSTEM OF ELECTRIC CIRCUIT CONTROL; F. W. Clary, Pittsburgh, Pa. App. filed Sept. 9, 1907. A polyphase supply circuit, a receiving circuit and a plurality of transformers interposed there between with a pair of double-throw switches for varying the voltage applied to the receiving circuit.

926,246. ELECTRIC OUTLET BOX; C. J. Dorff, Chicago, Ill. App. filed April 6, 1908. An outlet box having two sections screwed together by means of screws and slotted lugs.

926,248. DYNAMO-ELECTRIC MACHINE; R. S. Feight, Pittsburgh, Pa. App. filed Oct. 5, 1907. An improved magnetizable wedge



926,284.—Electrical Apparatus for Producing Sound Signals.

located near the top of the slots which contain the coils so as to obtain the advantages of partially closed core slots.

926,254. RHEOSTAT; H. D. James, Pittsburgh, Pa. App. filed July 17, 1905. Rheostats controlling elecric motors having two groups of resistance grids and a motor to which the groups are permanently connected with means for varying the number of grids included in the motor circuit.

926,258. TROLLEY WIRE HANGER; W. H. Kempton, Hartford, Conn. App. filed Dec. 12, 1908. A hanger which mechanically grips the trolley wire, consisting of toggle blocks and toggle links with a nut to force them together.

926,262. FIELD MAGNET WINDING FOR DYNAMO-ELECTRIC MACHINES; F. R. Kunkel, Edgewood Park, Pa. App. filed Sept. 8, 1908. A polar projection with a small body and a large end and a winding therefor having a plurality of loops.

926,278. METHOD OF MAKING BATTERY PLATES; G. J. Miller, Toledo, Ohio. App. filed Aug. 27, 1906. The plates have a plurality of ribs and are scored across the ribs.

926,284. ELECTRICAL APPARATUS FOR PRODUCING SOUND SIGNALS; C. H. O'Brien, Augusta, Maine. App. filed Dec. 11, 1905. A sound-producing body, a diaphragm and vibrating armature connected centrally of the diaphragm with an electromagnet for vibrating the armature.

926,312. METER RELAY; H. S. Baker, Wilkinsburg, Pa. App. filed April 4, 1906. A pair of stationary contact members, a moving member having three magnetizable blocks and a stationary magnet.

926,368. MAGNETO-ELECTRIC MACHINE; E. Troike, Sandusky, Ohio. App. filed Nov. 30, 1908. Bipolar magneto making use of an oscillating armature.

926,369. MAGNETIC MOTOR; W. H. Von Tish, Montclair, N. J. App. filed Sept. 16, 1907. Has a laminated yoke carrying two magnets, an armature located between the poles with means for passing the current around the magnets in one direction and breaking the current when the armature poles lie in horizontal alignment with the magnet poles.

926,372. PANEL BOARD; J. J. Wesley, Hackensack, N. J. App. filed April 7, 1909. A panel board including a box and a door, the door having an interior door which can be opened to uncover a part of the board, and a pan overlying the switches when the inner door is open.

926,385. SAFETY SCREEN FOR SAFES AND STRONG ROOMS; E. Branly and H. Laurent, Paris, France. App. filed July 9, 1908. Safety screen for safes in which compressed air fills the hollow space between the plates so that when the plates are perforated air escapes which closes an electric circuit.

926,386. ELECTRIC PRODUCTION CONTROLLING DEVICE FOR FACTORIES; W. H. Chappell, Chicago, Ill. App. filed Oct. 31, 1908. Keeps track of workmen's time by means of a signal board containing signaling devices in rows and columns which correspond to the departments of the factory.

926,391. THERMOSTAT DAMPER REGULATOR; R. E. Dewey, Grand Rapids, Mich. App. filed Feb. 13, 1909. An electric circuit for opening the dampers; another for closing them, and a pair of thermostats for controlling them.

926,413. PROCESS FOR OXIDIZING ATMOSPHERIC NITROGEN BY ELECTRICITY; D. Helbig, Rome, Italy. App. filed Jan. 7, 1908. An electric high pressure flame arc is blown by air so as to oxidize the nitrogen.

926,443. ELECTRIC FUSE BOX; T. E. Murray, New York, N. Y. App. filed Jan. 21, 1908. A box has parallel partition with metallic clips on opposite sides of the partitions and an upwardly swinging arm pivoted between them and connected to the fuse cases.

926,437. AUTOMATIC BLOCK SIGNAL FOR TROLLEY SYSTEMS; P. N. Pecci, Paterson, N. J. App. filed June 4, 1908. A signal apparatus connecting a motor with means for causing it to move first in one direction and then in the other so as to show danger or safety.

926,451. CONNECTION TERMINAL FOR ELECTRIC CONDUCTORS; H. G. Addie, Gresco, Ia. App. filed April 26, 1906. A terminal which does away with screw or pin fastenings, having a hollow portion through which the conductor extends and to which it is soldered, the solder sealing up the hollow portion and serving as a rivet.

926,463. COMPOSITION OF MATTER; F. D. Borland and P. G. Haney, McKeesport, Pa. App. filed Oct. 5, 1908. For coating insulators, consisting of linseed oil, gum arabic, turpentine and Japan drier.

926,492. ORE-REDUCING APPARATUS; W. V. Jean, Minneapolis, Minn. App. filed Oct. 10, 1907. Includes a tank, a screen dividing the tank into two concentric compartments, in which the terminals are located, and agitators.

926,493. ORE-SEPARATING MACHINE; W. V. Jean, Minneapolis, Minn. App. filed April 20, 1908. Includes a tank containing a liquid solution of the finely ground ore, a magnetic separator therein, a hollow shaft therein provided with radiating tubes and supplied with compressed air.

926,498. FARM AND GARDEN TILLING MACHINE; F. H. Kerr, Chicago, Ill. App. filed Dec. 30, 1907. A plow or lawn mower is supplied with current from a trolley.

926,507. ELECTRICALLY OPERATED POINT-SHIFTING MECHANISM; A. Oesterreicher, Vienna, Austria-Hungary. App. filed April 21, 1908. For shifting switchpoints of railroads by means of an electric motor and suitable connections.

926,510. PARTY LINE TELEPHONE SYSTEM; H. J. Roberts, Evanston, Ill.; C. A. Soans and A. H. Graves, Chicago, Ill. App. filed Jan. 8, 1907. Party line telephone system with a selective lock out of the bridging type in which ringers responsive to differentiated current are effective to control the talking connections.

926,518. LIGHTING SYSTEM; W. I. Thomson, Newark, N. J. App. filed April 15, 1903. Power axle lighting system having a carbon resistance regulator.

926,521. METHOD OF PROTECTING BUILDINGS FROM LIGHTNING; R. C. Totten, Pittsburgh, Pa. App. filed July 27, 1908. A method of protecting buildings from lightning which consists in keeping the roofs cool by agitating the air above the buildings.

926,536. THERMO-EXPANSION METER; C. D. Babcock, New York, N. Y. App. filed May 21, 1908. Hot wire current meter having a plurality of expansion elements and a switch adapted to close a circuit through one of said elements or through another, together with a pointer and scale for each of the circuits, with which the pointer co-acts.

926,565. TROLLEY GUARD; A. Hons and S. E. Martz, Berwick, Pa. App. filed June 18, 1908. A trolley guard consisting of two yieldingly mounted arms which lie above the wire.

926,584. ELECTRICAL SWITCH AND THE LIKE; D. K. Morris and G. A. Lister, Coventry, England. App. filed Sept. 22, 1908. An automatic cutout on overload or failure of current, a movable arm and a laterally deflectable conducting strip connected to the contacts on the arm.

926,605. ELECTRIC BRAKE; F. B. Rae, Detroit, Mich. App. filed Jan. 10, 1906. Electrically controlled means for operating the pressure, thus avoiding train pipe connections between the several cars of a multiple unit system.

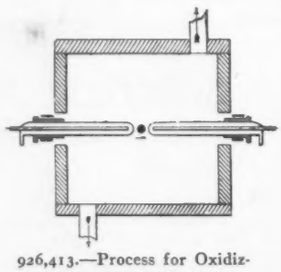
926,622. PENDANT ELECTRIC SWITCH; G. B. Thomas, Bridgeport, Conn. App. filed March 23, 1906. A push-button pendant switch, with two buttons and an insulating cup-shaped body open at the top for the insertion of the switch mechanism.

926,649. STORAGE BATTERY; W. Gardiner and J. Stirlen, St. Louis, Mo. App. filed Feb. 11, 1909. A box-shaped receptacle, a removable cover for one side thereof, ribs in the bottom and battery members resting on the ribs.

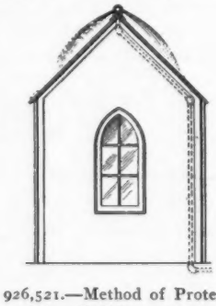
926,663. TELEGRAPH REPEATER; E. Longoria, Monterey, Mexico. App. filed Feb. 5, 1909. An automatic repeater which avoids the use of compensating rheostats or differential relays. A local circuit operates each repeater, which is opened and closed by the corresponding transmitter.

926,669. INCUBATOR ALARM; P. S. Martin, Broadway, Va. App. filed Feb. 17, 1909. For use in notifying the attendant in case the temperature of the egg rises or falls too greatly. Details.

926,680. DEVICE FOR MAKING AN ELECTRICAL CIRCUIT OR CIRCUITS; W. S. Ryan, Indianapolis, Ind. App. filed March 4, 1907. A fluid electrical conductor contained in a movable switch member is the medium of connection between the terminals.



926,413.—Process for Oxidizing Atmospheric Nitrogen by Electricity.



926,521.—Method of Protecting Buildings from Lightning.

926,681. CIRCUIT-CONTROLLING SWITCH; W. S. Ryan, Indianapolis, Ind. App. filed Dec. 2, 1907. An electric switch, a receptacle, a float therein, a movable member normally resting on the float and depressing it, and an electro-responsive device for moving the member to release the float.

926,687. ELECTRIC RAILWAY SIGNAL SYSTEM; Y. Burgess, Washington, D. C. App. filed Nov. 5, 1908. An electrically operated railway signal system having section stations along the line with normally closed charged circuits and alternately crossing sectional line conductors, together with a constantly closed train carried circuit which is included in those section station circuits the continuity of which is intact.

926,710. BIFUNCTIONAL STORAGE BATTERY PLATE; A. O. Tate, Toronto, Ontario. App. filed Feb. 18, 1909. Improvement on prior patents in which interleaved anodes and cathodes are separated by porous materials of special construction.

926,714. ELECTRIC TOASTER; H. E. Bradley, Appomaug, R. I. App. filed Feb. 25, 1909. A portable toaster in which the casing is provided with a removable cover and contains a heating element formed of resistance wire wound around a bread-receiving rack so as to heat both sides of the bread simultaneously and so that the crumbs will not fall on the wire.